SOIL SURVEY OF

Stafford County, Kansas

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status or age.

Major fieldwork for this soil survey was completed in the period 1963-73. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Stafford County Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, or other structures; and in judging the suitability of tracts of land for agriculture, industry, or recreation.

Locating Soils

All the soils of Stafford County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each soil is described, and also the page for the capability unit and range site in which the soil has been placed.

Interpretations on colored maps showing the relative suitability or degree of limitations of soils for many specific purposes can be developed by using the soil maps and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from soil descriptions in the section "Management of Soils for Dryland Crops," "Management of Soils for Irrigated Crops," from the discussions of range sites and from the section "Use of Soils for Windbreaks."

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Uses of Soils for Wildlife."

Ranchers and others interested in range can find, under "Use of Soils for Range," groupings of the soils into range sites according to their suitability for range, the names of many plants that grow on each range site, and also the expected annual yield of each site under specified conditions.

Community planners and others concerned with suburban development can read about the soil properties that affect the choice of homesites, industrial sites, schools, and parks in the section "Engineering Uses of the Soils."

Engineers, builders, and others will find, under "Engineering Uses of the Soils" and "Soil Properties," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Stafford County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Facts About the County," which gives additional information about the county.

Cover: Grain sorghum and wheat stubble mulch strips, Pratt loamy fine sand, hummocky.

Contents

How this survey was made 1
General soil map 2
1. Pratt-Tivoli association 2
2. Pratt-Carwile association 2
3. Naron-Farnum association 3
4. Blanket-Farnum association 4
5. Natrustolls-Plevna association 5
6. Dillwyn-Tivoli association 7

Descriptions of the soils 8
Albion series 8
An—Albion sandy loam, 1 to 4 percent slopes 9
Attica series 9
At — Attica fine sandy loam, 1 to 4 percent slopes 9
Blanket series 9
Ba—Blanket silt loam 10
Carwile series 10
Ca—Carwile fine sandy loam 11
Cw—Carwile complex 11
Clark series 11
Cx—Clark loam, 1 to 3 percent slopes 11
Dillwyn series 12
Dp—Dillwyn-Plevna complex 12
Dt—Dillwyn-Tivoli loamy fine sands, 0 to 15 percent slopes 12
Farnum series 12
Fa—Farnum fine sandy loam 13
Fr—Farnum loam 13
Kingman series 13
Kg—Kingman silty clay loam 14
Naron series 14
Na—Naron fine sandy loam 14
Natrustolls 14
Nu—Natrustolls 14
Plevna series 15
Pa—Plevna soils 16
Pc—Plevna soils, channeled 16
Pratt series 16
Ph—Pratt loamy fine sand, hummocky 16
Po—Pratt loamy fine sand, undulating 16
Pr—Pratt-Carwile complex, 0 to 8 percent slopes 17
Pt—Pratt-Tivoli loamy fine sands, hummocky 17
Tabler series 17
Ta—Tabler loam 17
Tivoli series 18
Tv—Tivoli fine sand, hilly 18
Waldeck series 18
Wa—Waldeck fine sandy loam 18
Zenda series 19
Za—Zenda-Natrustolls complex 19

Planning the use and management of the soils 19
Management of soils for dryland crops 20
Management of soils for irrigated crops 21
Capability grouping 22
Yields per acre 24
Use of soils for range 25
Range sites and range conditions 25
Descriptions of range sites 26
Use of soils for windbreaks 29
Planting and care of windbreaks 30
Use of soils for wildlife 30
Use of soils for recreation 34
Engineering uses of the soils 34
Sanitary facilities 40
Building site development 41
Construction materials 41
Water management 42
Soil properties 43
Engineering properties and classification 43
Physical and chemical properties 46
Soil and water features 49
Soil test data 51

Formation and classification of soils 51
Factors of soil formation 51
Parent material 51
Climate 51
Plants and animals 51
Relief 52
Time 52
Classification 53

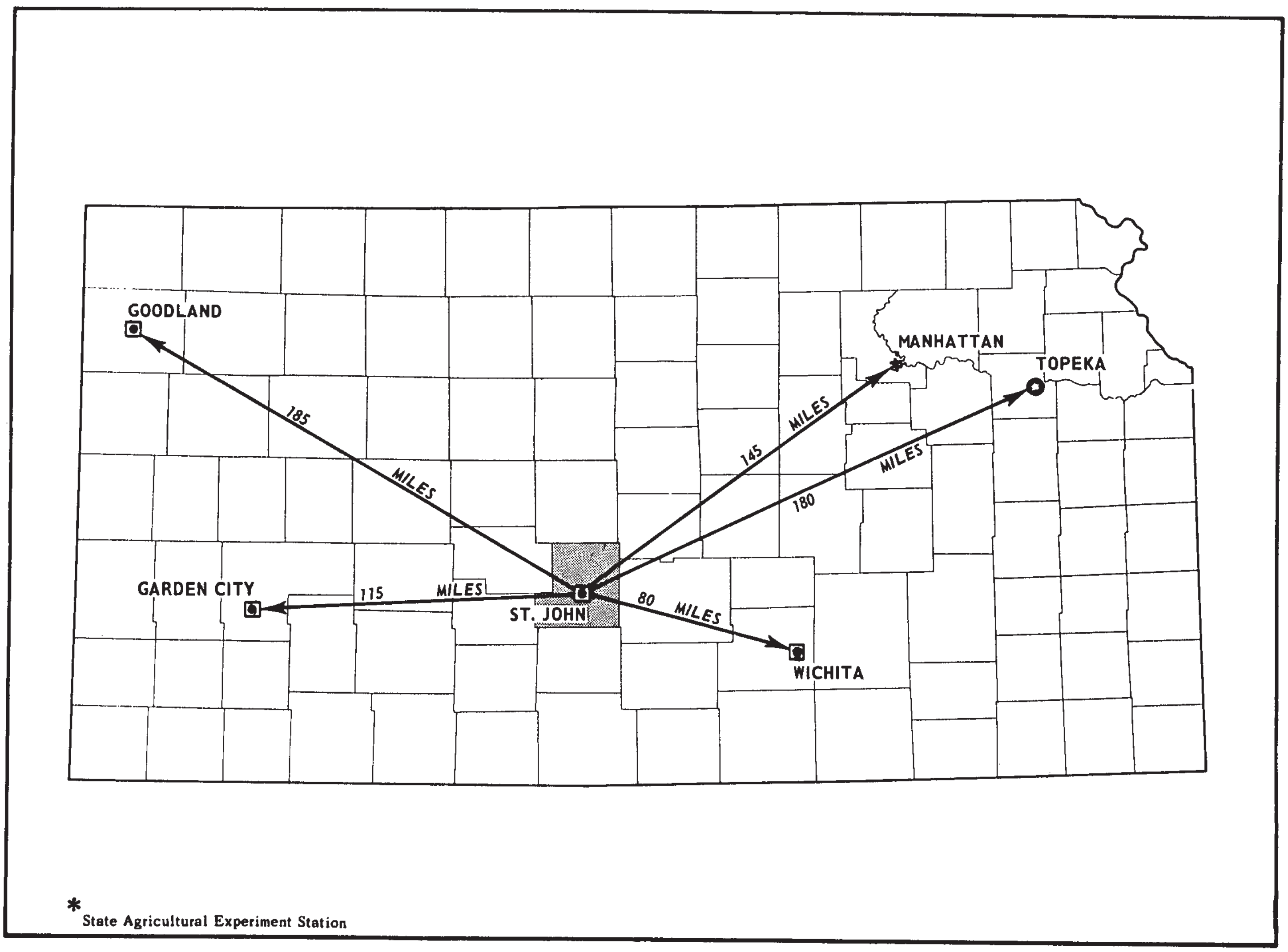
General facts about the county 54
Physiography, relief, and drainage 54
Climate 55
Transportation 57

References 57
Glossary 57
Guide to mapping units Following 59

Issued July, 1978

Summary of Tables

Descriptions of the soils
Acreage and proportionate extent of the soils (Table 1) 8
Planning the use and management of the soils
Yields per acre of crops and pasture (Table 2) 24
Windbreaks and environmental plantings (Table 3) 31
Wildlife habitat potentials (Table 4) 32
Recreational development (Table 5) 35
Sanitary facilities (Table 6) 36
Building site development (Table 7) 37
Construction materials (Table 8) 38
Water management (Table 9) 39
Engineering properties and classifications (Table 10) 44
Physical and chemical properties of soils (Table 11) 47
Soil and water features (Table 12) 50
Engineering test data (Table 13) 52
Formation and classification of soils
Classification of the soils (Table 14) 54
General facts about the county
Temperature and precipitation data (Table 15) 56
Freeze dates in spring and in fall (Table 16) 56



Location of Stafford County in Kansas.

SOIL SURVEY OF STAFFORD COUNTY, KANSAS

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United States Department of Agriculture, Soil Conservation Service,
in cooperation with the Kansas Agricultural Experiment Station

STAFFORD COUNTY is in the central part of Kansas (see facing page). The total area of Stafford county is 795 square miles, or 508,800 acres. Stafford county extends about 30 miles from the northernmost point to the southern border and 30 miles from east to west. St. John, the county seat, is near the center of Stafford county.

Farming is the principal industry. Wheat, grain sorghum, and cattle are the main enterprises and sources of income. Irrigation farming is practiced by many farmers throughout the county.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Stafford County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size of streams; kinds of native plants or crops; kinds of rock, and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material that has not been changed much by leaching or by roots or plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide procedures. The *soil series* and *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles alike or almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Pratt and Carwile for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, hazard of erosion, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects soil management. For example, Pratt loamy fine sand, undulating, is one phase, and Pratt loamy fine sand, hummocky, is another phase within the Pratt series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and similar detail that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. A mapping unit is nearly but not exactly equivalent to a phase because it is not practical to show on the map scale all minor areas of some other kind of soil that has been included within the mapped area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or no series name is assigned. Two such kinds of mapping units are shown on the maps of Stafford County, soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils joined by a hyphen. An example is Pratt-Carwile complex, 0 to 8 percent slopes.

An undifferentiated group is made up of two or more soils or surface textures that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. Plevna soils is an undifferentiated group in Stafford County.

While the soil survey is in progress, samples of soil are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data for the same kinds of soils in other places are assembled and are used for references in descriptions and interpretations. Data

on yields of crops under defined practices are assembled from farm records and from field plots or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

Soil scientists set up trial groups of soils on the basis of yield and practice tables and other data. They test these groups by further study and by consultation with farmers, ranchers, agronomists, engineers, and others. Then they adjust the groups according to the results of their studies, observations, and consultations. Thus, the groups that are finally evolved reflect up-to-date knowledge of soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Soil association names and definitions on the general soil map may not fully agree with those of the general soil map in adjacent counties published at a different date. Differences in the maps are the result of improvement in the classification or refinements in soil series concepts.

The terms for texture used in the title of the associations apply to the texture of the surface layer of the major soils. For example, in the title of Pratt-Carwile association, the words "sandy soils" and "loamy soils" refers to the texture of the surface layer.

The soil associations in this survey area are described in the paragraphs that follow.

1. Pratt-Tivoli Association

Undulating to hilly sandy soils; on uplands

This association (fig. 1) is on short and medium length slopes in complex wind-modified areas. It makes up 10 percent of the county. It is 59 percent Pratt soils, 33 percent Tivoli soils, and 8 percent minor soils.

The Pratt soils are deep and undulating to rolling. They are in complex wind-modified areas. They commonly occur with Tivoli soils. Typically the surface layer is loamy fine sand about 8 inches thick, and the subsoil is heavy loamy fine sand about 20 inches thick. The underlying material is loamy fine sand. Pratt soils formed in sandy eolian sediment. They are well drained. Permeability is rapid, and available water capacity is low.

Tivoli soils are deep and undulating to hilly. They are at the higher elevations. Typically the surface layer is fine sand or loamy fine sand about 6 inches thick. The underlying material is fine sand. Tivoli soils formed in sandy eolian sediment. They are excessively drained. Permeability is rapid, and available water capacity is low.

Among the minor soils in this association are Attica, Dillwyn, and Carwile. Small intermittent lakes form in areas where the surface is concave. The deep, gently sloping Attica soils are at a slightly lower elevation than Pratt soils. The deep, nearly level to gently rolling, somewhat poorly drained Dillwyn and Carwile soils and intermittent lakes are in the low areas.

Most of this association is used for range. Small fields of Pratt, Attica and Carwile soils are used for cultivated crops. The soils are well suited to native grasses commonly grown in the county, but they are poorly suited to dryland crops.

The main management needs are proper range management of the native grassland, protecting the soil to prevent blowing, conserving moisture, and maintaining soil fertility.

2. Pratt-Carwile Association

Undulating to rolling sandy soils, and nearly level loamy soils; on uplands

This association (fig. 2) is on short and medium length slopes in a complex wind-modified landscape. It makes up 43 percent of the county. It is 64 percent Pratt soils, 26 percent Carwile soils, and 10 percent minor soils.

Pratt soils are deep and undulating to rolling. They are in complex wind-modified areas. Typically, the surface layer is loamy fine sand about 8 inches thick, and the subsoil is heavy loamy fine sand about 20 inches thick. The underlying material is loamy fine sand. Pratt soils formed in sandy eolian sediment. They are well drained. Permeability is rapid, and available water capacity is low.

Carwile soils are deep and nearly level. They are on short and medium length, slightly concave slopes in low areas. Typically the surface layer is fine sandy loam about 7 inches thick. The upper part of the subsoil is sandy clay loam about 7 inches thick, and the lower part of the subsoil is sandy clay about 24 inches thick. The underlying material is sandy clay loam. Carwile soils formed in loamy and clayey old alluvium. They are somewhat poorly drained. Permeability is slow, and available water capacity is high. Runoff is slow, or the surface is ponded.

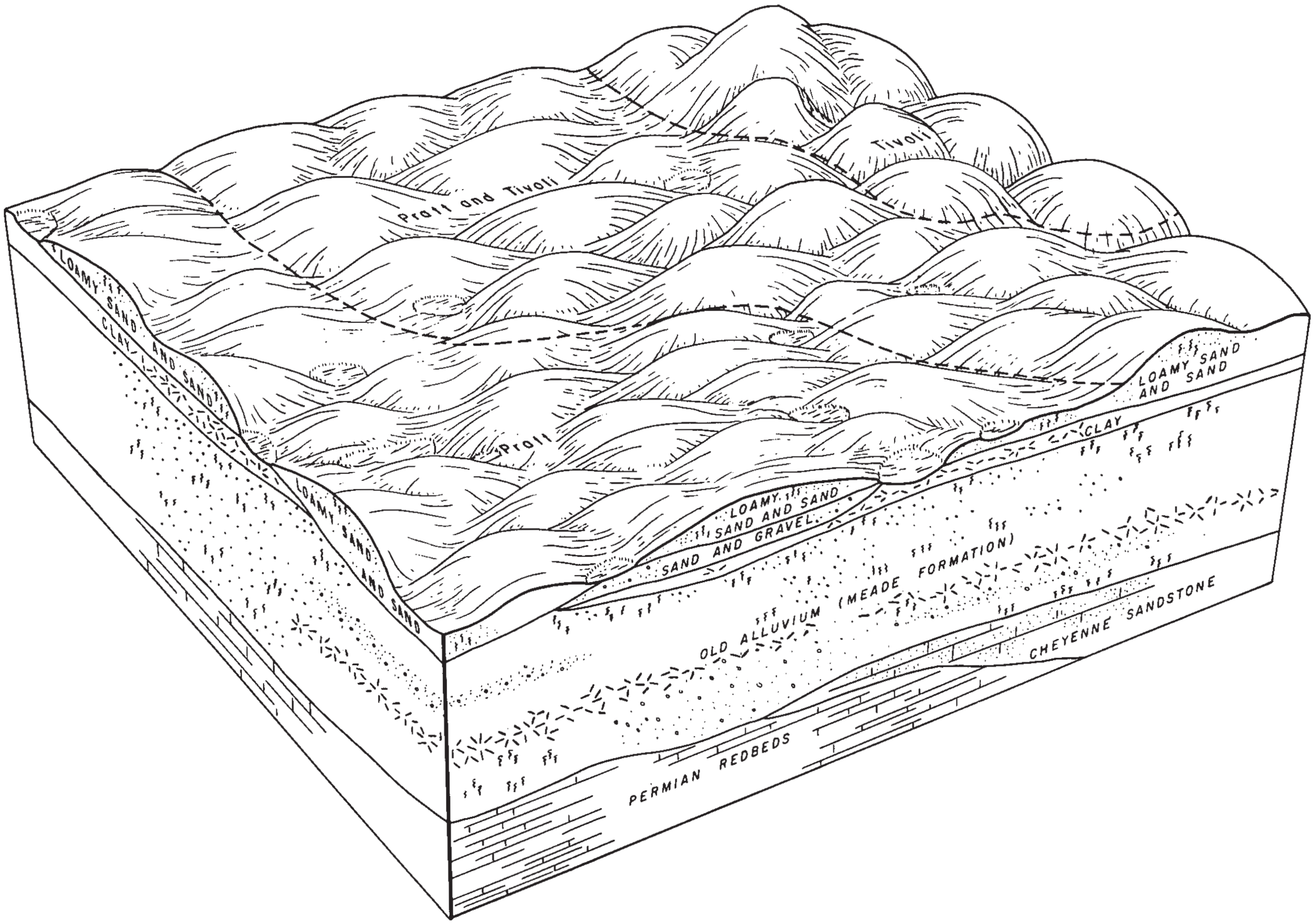

Figure 1.—**A representative pattern of soils in the Pratt-Tivoli association.**

Among the minor soils in this association are Naron, Tivoli, Attica, and Tabler. Small intermittent lakes form in low areas of Carwile and Tabler soils. The deep, gently sloping Attica soils are at a slightly lower elevation than the Pratt soils. The undulating to hilly Tivoli soils are in the higher areas of the landscape, and the nearly level and gently sloping Naron soils are in the intermediate convex areas. The nearly level Tabler soils are in low areas near Carwile soils and at a slightly lower elevation in the landscape.

Most of this association is used for crops. The soils are well suited to dryland and irrigated crops and grasses commonly grown in the county. Small areas of Pratt and Tivoli soils are used as range. They are well suited to native grasses commonly grown in the county.

The main management needs are protecting the soil from blowing, conserving moisture, controlling water erosion and ponding, and maintaining soil fertility.

3. Naron-Farnum Association

Nearly level and gently sloping loamy soils; on uplands

This association (fig. 3) is on medium and long convex ridges and in low nearly level convex areas that have weakly defined drainageways. It makes up 23 percent of the county. It is 68 percent Naron soils, 22 percent Farnum soils, and 10 percent minor soils.

Naron soils are deep and nearly level and gently sloping. They are on medium and long convex ridges and in nearly level convex areas. Typically, the surface layer is fine sandy loam. The subsoil is about 30 inches thick. It is fine sandy loam in the upper part, sandy clay loam in the middle part, and fine sandy loam in the lower part. The underlying material is fine sandy loam. Naron soils formed in loamy and sandy eolian deposits. They are well drained. Permeability is moderate, and available water capacity is high.

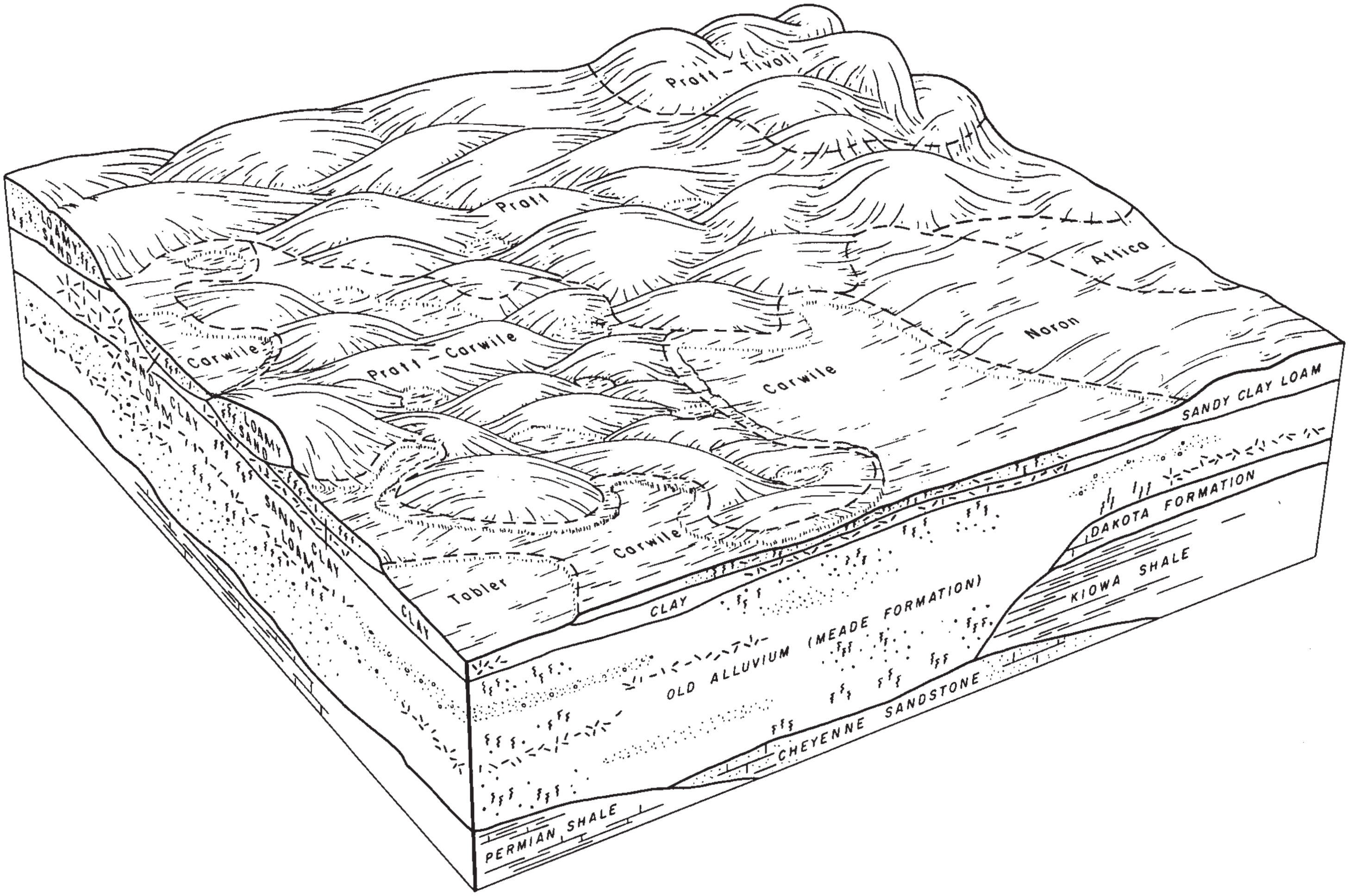

Figure 2. — **A representative pattern of soils in the Pratt-Carwile association.**

Farnum soils are deep and nearly level. They are in medium and long, low convex areas. Typically, the surface layer is loam about 9 inches thick or fine sandy loam 11 to 17 inches thick. The upper part of the subsoil is clay loam about 31 inches thick. The underlying material is generally loam, but in places it is clay loam, sandy clay loam, or fine sandy loam. Farnum soils formed in stratified, loamy old alluvium that in places has sand or clay layers. These soils are well drained. Permeability is moderately slow, and available water capacity is high.

Among the minor soils in this association are Carwile, Pratt, and Tabler soils. Small intermittent lakes form in low areas of Carwile, Naron, and Tabler soils. The deep, nearly level Carwile and Tabler soils are in short and medium length low areas. The deep, undulating to rolling Pratt soils are in complex areas that have been modified by wind.

Most of this association is used as cropland. It is well suited to dryland and irrigated crops and grasses commonly grown in the county. Small areas of Pratt soils are used as range.

The main management needs are controlling soil blowing and water erosion, conserving moisture, and maintaining soil fertility and tilth. Areas of native grasses need proper range management.

4. *Blanket-Farnum Association*

Nearly level loamy soils; on uplands

This association (fig. 4) is on medium and long convex ridges and in broad areas that have weakly defined drainageways. It makes up 12 percent of the county. It is 48 percent Blanket soils, 37 percent Farnum soils, and 15 percent minor soils.

Blanket soils are deep and nearly level. They are in medium and long, convex, broad areas. The surface layer is silt loam about 10 inches thick, and the subsoil is silty clay loam and silty clay about 42 inches thick. The underlying material is silty clay loam. Blanket soils formed in moderately fine textured loess and old alluvium. They are well drained. Permeability is moderately slow, and available water capacity is high.

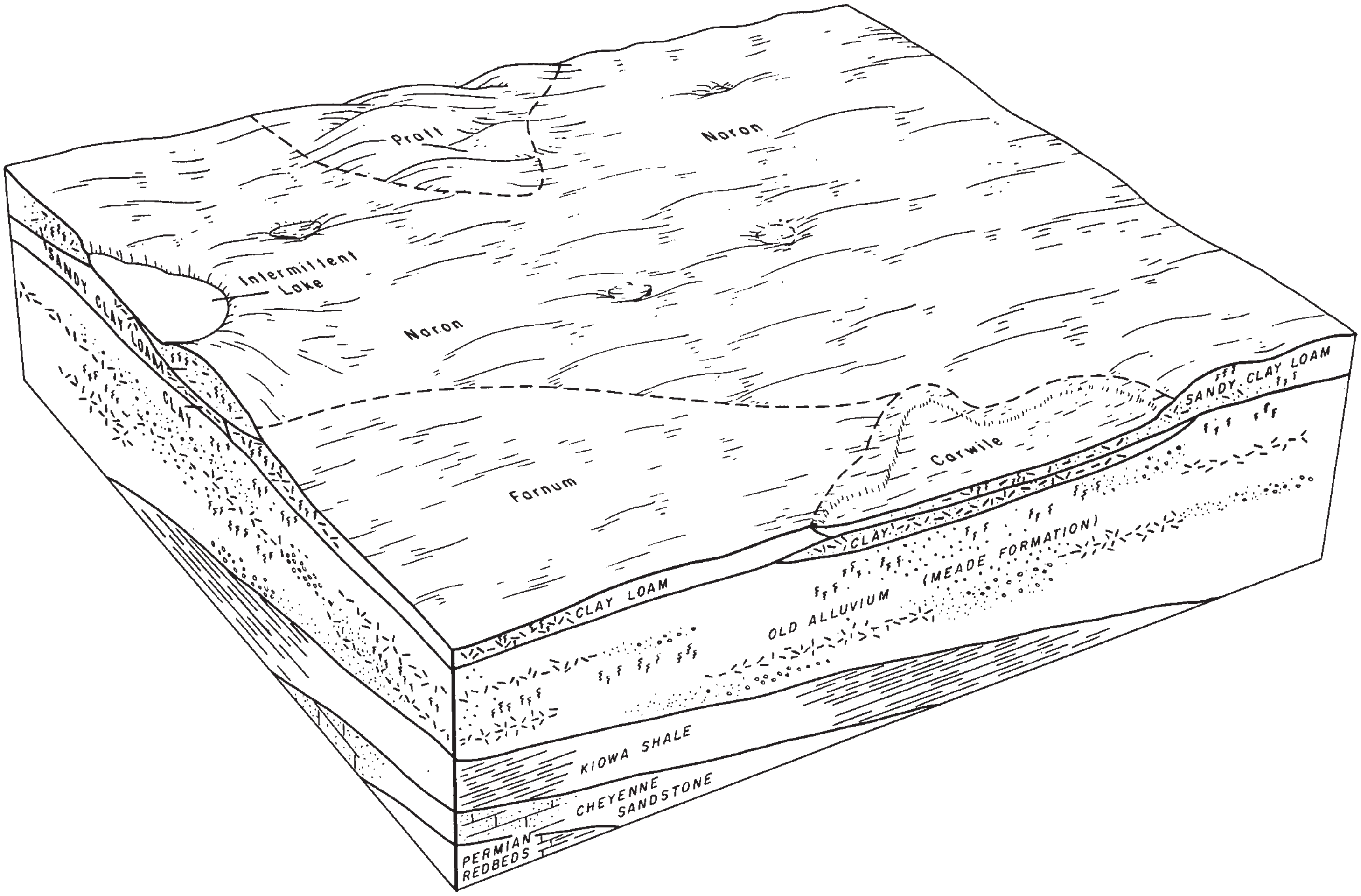

Figure 3.—**A representative pattern of soils in the Naron-Farnum association.**

Farnum soils are deep and nearly level. They are on medium and long convex ridges and in broad areas. Typically the surface layer is loam about 9 inches thick, and the subsoil is loam and clay loam about 44 inches thick. The underlying material is generally loam, but in places it is clay loam, sandy clay loam, or fine sandy loam. Farnum soils formed in stratified, loamy old alluvium that in places has sand or clay layers. They are well drained. Permeability is moderately slow, and available water capacity is high.

Among the minor soils in this association are Carwile, Naron, and Tabler. Small intermittent lakes form in low areas of nearly level Tabler soils. The nearly level, somewhat poorly drained Carwile soils are in slightly concave areas and are near Blanket and Farnum soils. The nearly level and gently sloping Naron soils are on long convex ridges and are in higher areas that have been modified by wind.

Most of this association is used for growing dryland and irrigated crops. The soils are well suited to all crops and grasses commonly grown in the county. Small areas are used for growing native grasses.

The main management needs are controlling soil blowing, water erosion, and ponding; conserving moisture; and maintaining soil fertility. Areas of native grasses need proper range management.

5. *Natrustolls-Plevna Association*

Nearly level, salt-affected loamy soils, and loamy soils with a seasonally high water table; on flood plains

This association (fig. 5) is on wet low terraces and flood plains and in channeled areas of streams. Stream channels have a low gradient and have formed extensive meanders. This association makes up 9 percent of the county. It is 50 percent Natrustolls, 27 percent Plevna soils, and 23 percent minor soils.

Natrustolls are deep and nearly level. They are on long, broad, low terraces and flood plains. Typically, the surface layer is fine sandy loam, loam, or clay loam about 8 inches thick. The subsoil is sandy clay loam or clay loam that is high in sodium salts and is about 15 inches thick. The underlying material is clay loam or fine sandy loam. Natrustolls formed in loamy calcareous alluvium that contains layers of sand or clay in places. They are somewhat poorly drained. Permeability is moderately slow, and available water capacity is moderate. Natrustolls are subject to occasional flooding.

Plevna soils are deep and nearly level. They are in slight depressions on flood plains and on roughly broken, channeled flood plains. Typically, on the flood plains, the surface layer is fine sandy loam about 12

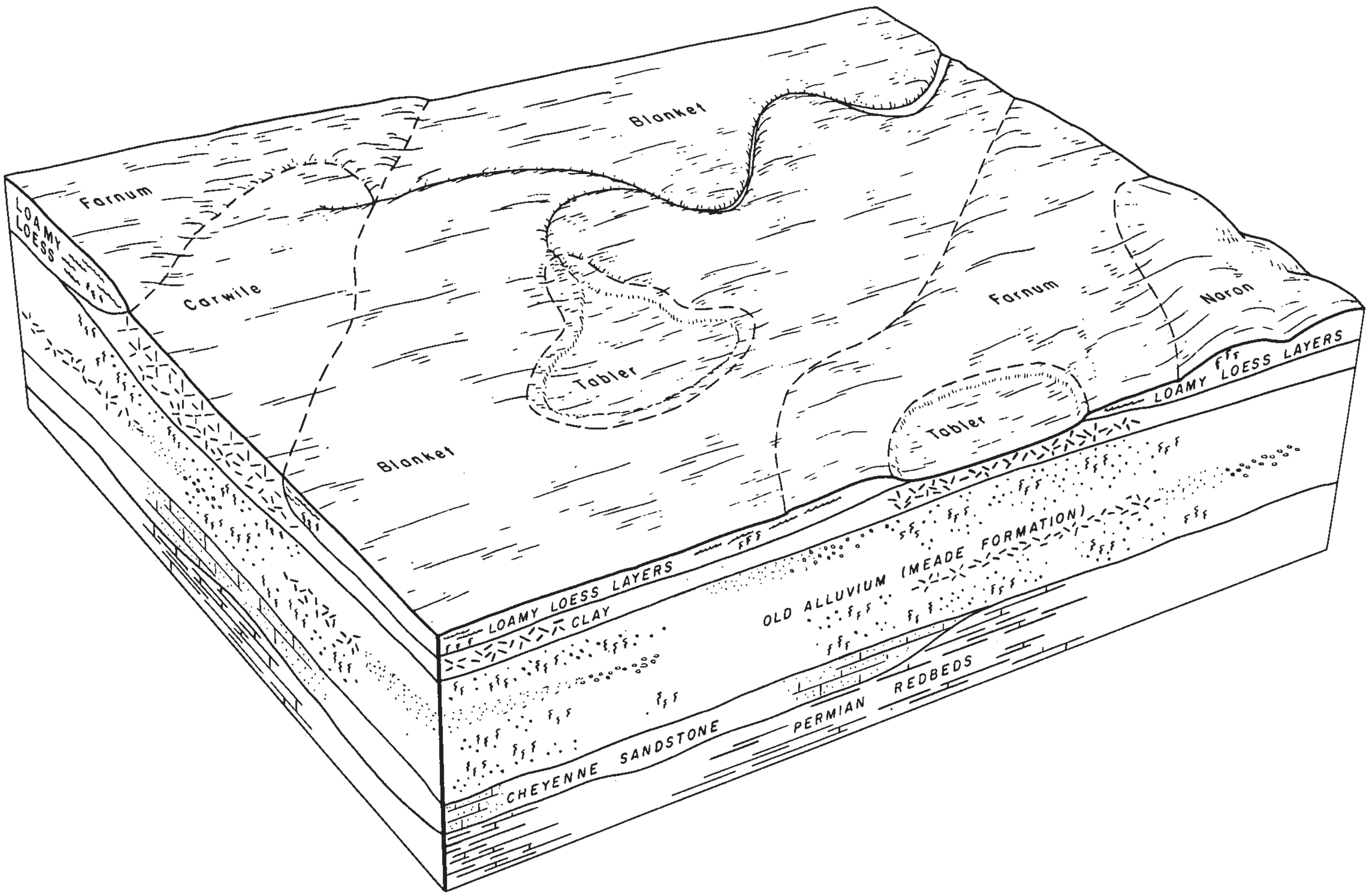

Figure 4.—**A representative pattern of soils in the Blanket-Farnum association.**

inches thick, and the subsoil is mottled fine sandy loam about 26 inches thick. The underlying material is fine sand. Plevna soils formed in loamy alluvium underlain in many places by sandy and clayey material. They are poorly drained and have a seasonally high water table. Above the water table permeability is moderately rapid. Available water capacity is moderate. Runoff is very slow.

In channeled areas the surface layer of Plevna soils is typically fine sandy loam, but it is loamy fine sand or clay loam in places. The underlying material is highly stratified loamy and sandy recent alluvium. The channeled areas are frequently flooded.

Among the minor soils in this association are Carwile, Dillwyn, Kingman, Naron, Zenda, and Waldeck. All of these soils except Naron are poorly drained or somewhat poorly drained. Carwile soils are deep and nearly level. They are in intricate patterns with other soils having layers high in sodium. They are in short and medium concave areas along the outer valley borders in slightly higher areas than other valley soils. Dillwyn soils are deep and nearly level to gently rolling. They are in intricate patterns with the Plevna soils and are in higher areas. Kingman soils are deep, nearly level, and slightly depressional silty clay loams. They are in the lower areas on broad flood plains near the outer part of the valley. Waldeck soils are deep and nearly level. They are on convex natural levees of the flood plains. Naron soils are deep, nearly level and gently sloping, and well drained. They are in medium length, convex, isolated areas at intermediate elevations and in higher areas that grade to the broad upland. Zenda soils are deep and nearly level and are on low terraces and flood plains. They are in intricate patterns with the Natrustolls.

Most of this association is in native grassland. Small areas are cultivated, mostly in fields of minor soils above the flood plain.

The main management needs in cultivated fields are reducing soil crusting, controlling soil blowing and soil erosion, and maintaining soil fertility. Areas of native grasses need proper range management.

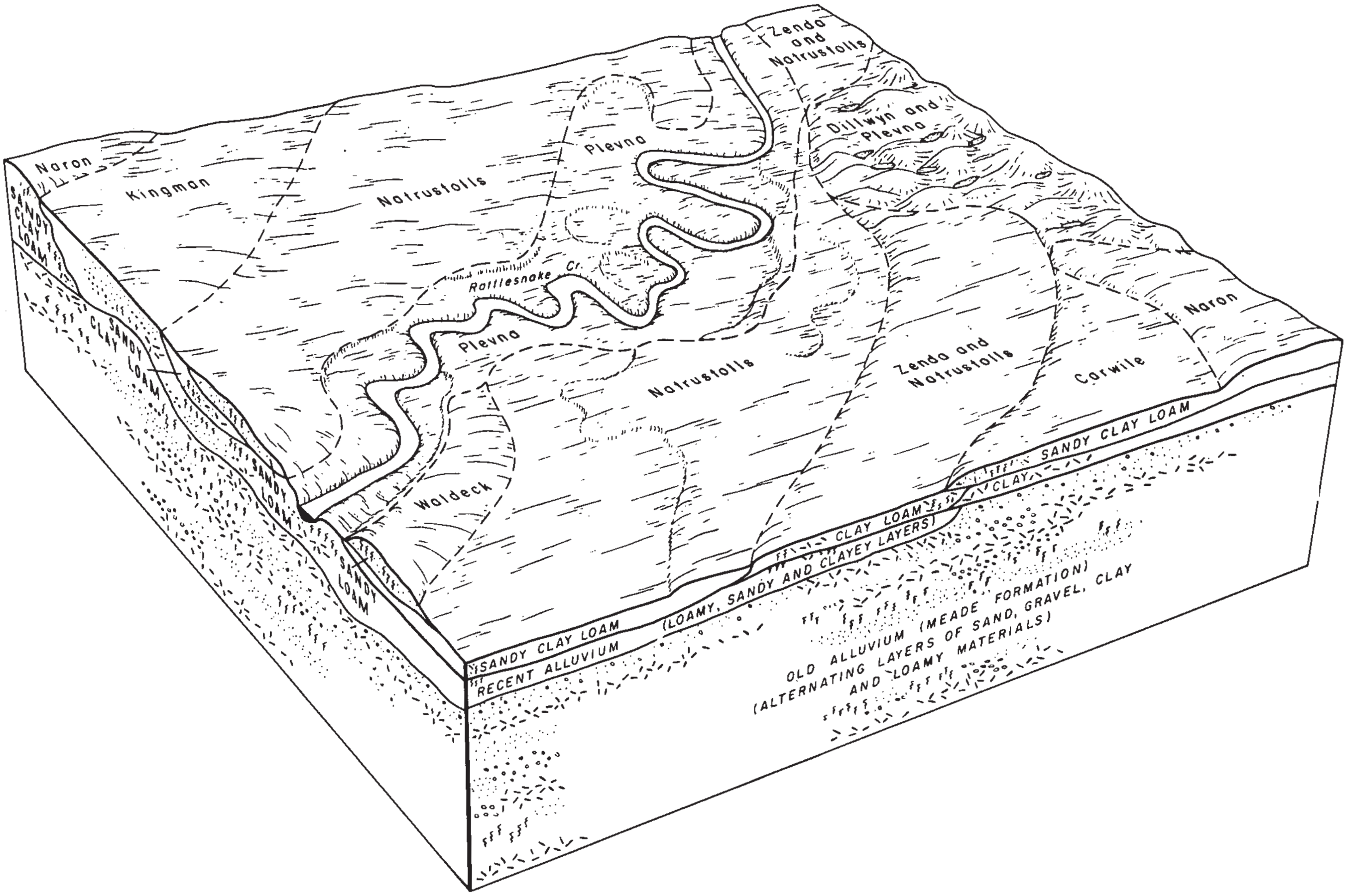

Figure 5.—**A representative pattern of soils in the Natrustolls-Plevna association.**

6. *Dillwyn-Tivoli Association*

Nearly level to gently rolling, wet sandy soils and undulating to hilly sandy soils; on uplands

This association is on short complex slopes in a nearly level to hilly landscape that has been modified by wind. It makes up 3 percent of the county. It is 55 percent Dillwyn soils, 30 percent Tivoli soils, and 15 percent minor soils.

Dillwyn soils are deep and nearly level to gently rolling. They are in areas of short complex slopes that have been modified by wind. Typically, the surface layer is loamy fine sand about 8 inches thick, and the subsoil is mottled fine sand about 20 inches thick. The underlying material is fine sand. The Dillwyn soils have a seasonally high water table. Dillwyn soils formed in well sorted eolian sands. They are somewhat poorly drained. Above the water table permeability is rapid. Available water capacity is low.

Tivoli soils are deep and undulating to hilly. They are in short complex areas that have been modified by wind and are generally in the higher areas of the landscape. Typically, the surface layer is loamy fine sand or fine sand about 6 inches thick, and the underlying material is fine sand. Tivoli soils formed in sandy eolian sediment. They are excessively drained. Permeability is rapid, and available water capacity is low.

Among the minor soils in this association are Pratt and Plevna soils and small areas of Carwile soils and Natrustolls. Also in this association are intermittent lakes. Pratt soils are deep and undulating to rolling. They occur with Tivoli soils in about the same area. Plevna soils are deep, nearly level, and wet. They occur with Dillwyn soils in about the same or slightly lower areas. Carwile soils are deep and somewhat poorly drained. Natrustolls, intermittent lakes, and Carwile soils are in the low areas.

Most of this association is used for range. Some small areas of Pratt and Carwile soils are used for cultivated crops, and some areas of Plevna soils are used for hayland. This association is well suited to native grasses commonly grown in the county and is poorly suited to dryland crops. The main management needs of this association are controlling soil blowing, conserving moisture, and maintaining soil fertility. Areas of native grasses need proper range management.

Descriptions of the Soils

In this section the soils of Stafford County are described and their use and management are discussed. Each soil series is described in detail, and then, briefly, the mapping units in that series. Unless specifically mentioned otherwise, it is assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to bedrock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is more detailed and is for those who need to make thorough and precise studies of the soils. Color terms are for dry soil unless otherwise stated. The profile described in the soil series is representative for mapping units in that series. If a given mapping unit has a profile in some way different from the one described in the series, these differences are stated in the description of the mapping unit, or they are apparent in the name of the mapping unit. The description of each mapping unit contains suggestions on how the soil can be managed. The general management of soils in this county is discussed in the section, "Planning the Use and Management of the Soils."

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Natrustolls, for example, do not belong to a soil series, but are listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit and range site in which the mapping unit has been placed. The page for the description of each mapping unit or other interpretive group can be found in the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit is shown in table 1. Many of the terms used in describing soils can be found in the "Glossary," and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*13*).[1]

[1]Italic numbers in parentheses refer to Literature Cited, p. 57.

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil name	Acres	Percent
An	Albion sandy loam, 1 to 4 percent slopes	1,300	0.3
At	Attica fine sandy loam, 1 to 4 percent slopes	5,040	1.0
Ba	Blanket silt loam	19,150	3.8
Ca	Carwile fine sandy loam	59,520	11.7
Cw	Carwile complex	3,840	.8
Cx	Clark loam, 1 to 3 percent slopes	2,990	.6
Dp	Dillwyn-Plevna complex	8,750	1.7
Dt	Dillwyn-Tivoli loamy fine sands, 0 to 15 percent slopes	14,360	2.8
Fa	Farnum fine sandy loam	14,240	2.8
Fr	Farnum loam	22,700	4.5
Kg	Kingman silty clay loam	3,120	.6
Na	Naron fine sandy loam	90,440	17.7
Nu	Natrustolls	16,900	3.3
Pa	Plevna soils	9,090	1.8
Pc	Plevna soils, channeled	2,640	.5
Ph	Pratt loamy fine sand, hummocky	20,540	4.0
Po	Pratt loamy fine sand, undulating	96,530	19.0
Pr	Pratt-Carwile complex, 0 to 8 percent slopes	59,260	11.6
Pt	Pratt-Tivoli loamy fine sands, hummocky	26,960	5.3
Ta	Tabler loam	8,420	1.7
Tv	Tivoli fine sand, hilly	7,960	1.6
Wa	Waldeck fine sandy loam	4,770	.9
Za	Zenda-Natrustolls complex	4,750	.9
	Big salt marsh, little salt marsh, and associated low areas	5,406	1.1
	Gravel pits	60	(1)
	Total land area	508,736	
	Water areas, more than 40 acres	64	(1)
	Total area	508,800	100.0

[1]Less than 0.1 percent.

Albion Series

The Albion series consists of deep, gently sloping, somewhat excessively drained soils on uplands. These soils formed in loamy old alluvium.

In a representative profile the surface layer is brown sandy loam about 10 inches thick. The upper part of the subsoil is brown, friable sandy loam about 10 inches thick, and the lower part of the subsoil is yellowish brown, friable, coarse sandy loam about 10 inches thick. The underlying material is light yellowish brown coarse sand and fine gravel.

Permeability is moderately rapid. Available water capacity is low, and natural fertility is low.

Albion soils are suited to such dryland crops as winter wheat and sorghum. They are well suited to native grasses.

Representative profile of Albion sandy loam, 1 to 4 percent slopes, in grassland, 80 feet east and 100 feet south of the northwest corner of the southwest quarter of sec. 3, T. 25 S., R. 11 W.

A1—0 to 10 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) when moist; weak medium granular structure; slightly hard and friable; many fibrous roots; few fine pebbles as much as 1 inch in diameter; slightly acid; gradual smooth boundary.

B2t—10 to 20 inches; brown (10YR 5/3) heavy sandy loam, dark brown (10YR 3/3) when moist; weak medium subangular blocky structure; hard and friable; many fibrous roots; common rounded pebbles; slightly acid; gradual smooth boundary.

B3—20 to 30 inches; yellowish brown (10YR 5/4) coarse sandy loam, dark yellowish brown (10YR 4/4) when moist; weak fine granular structure; slightly hard and friable; few roots; common rounded pebbles; slightly acid; diffuse smooth boundary.

IIC—30 to 60 inches; light yellowish brown (10YR 6/4) coarse sand and fine gravel, yellowish brown (10YR 5/4) when moist; single grained; loose; very friable; slightly acid.

The A horizon is brown or dark grayish brown sandy loam 6 to 12 inches thick. Generally it is slightly acid, but in places reaction is medium acid. The B horizon is 14 to 24 inches thick. The B2t horizon is sandy loam. The B3 horizon is slightly acid or medium acid coarse sandy loam or loamy sand. The IIC horizon is layers of medium sand, coarse sand, and fine gravel. Depth to the IIC horizon is 20 to 30 inches.

Albion soils are similar to Pratt and Attica soils. The coarse-textured C horizon is shallower in Albion soils than it is in those soils.

An—Albion sandy loam, 1 to 4 percent slopes. This gently sloping soil is on convex ridgetops. Included with this soil in mapping are a few areas of Farnum and Naron soils. Also included are small areas of sand and gravel beds.

Runoff is slow. Water erosion and soil blowing are problems if the soil is not protected by native grasses, crops or crop residue. Careful management is needed to conserve moisture, control erosion, and improve soil fertility.

Most of the acreage of this soil is used for range, but small areas are used for dryland crops. Capability unit IIIe-3 dryland and IIIe-3 irrigated; Sandy range site.

Attica Series

The Attica series consists of deep, gently sloping, well drained soils on uplands. These soils formed in loamy and sandy eolian sediment.

In a representative profile the surface layer is grayish brown fine sandy loam about 10 inches thick. The subsoil is brown, friable and very friable fine sandy loam about 29 inches thick. The underlying material is light yellowish brown fine sandy loam.

Permeability is moderately rapid. Available water capacity is moderate, and natural fertility is medium.

Attica soils are well suited to dryland and irrigated crops and to native or tame grasses commonly grown in the county. Major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Attica fine sandy loam, 1 to 4 percent slopes, in a cultivated field, 2,490 feet east and 300 feet south of the northwest corner of sec. 2, T. 24 S., R. 15 W.

Ap—0 to 10 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; slightly hard and friable; many roots; medium acid; gradual smooth boundary.

B2t—10 to 21 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak medium subangular blocky structure; slightly hard and friable; clay bridges between sand grains; common roots; slightly acid; clear smooth boundary.

B3—21 to 39 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak fine granular structure parting to massive in the lower part; soft and very friable; few roots; neutral; diffuse smooth boundary.

C—39 to 60 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) when moist; massive; soft and very friable; neutral.

The A horizon is grayish brown and is 6 to 18 inches thick. It is typically fine sandy loam but is loamy fine sand in places. The B horizon is brown fine sandy loam 16 to 35 inches thick. The C horizon is light yellowish brown, yellowish brown, or pale brown fine sandy loam, sandy loam, or loamy fine sand.

Attica soils are similar to Albion, Naron, Farnum, and Pratt soils. They are near Carwile and Tivoli soils. Attica soils are deeper to the sandy or gravelly C horizon than Albion or Tivoli soils. They have less clay in the B horizon than Farnum, Naron, or Carwile soils and less sand in the B horizon than Pratt soils.

At—Attica fine sandy loam, 1 to 4 percent slopes. This soil is on wind modified uplands. Slopes are convex and short to medium in length. Included in mapping are a few areas of Carwile, Farnum, Naron, and Pratt soils.

Runoff is slow. Careful management of cultivated crops and crop residue is needed to control soil blowing, conserve moisture, and maintain tilth and fertility.

Most of the acreage of this soil is used for dryland or irrigated crops. Small areas are in native grass used for grazing. Capability unit IIe-2 dryland and IIe-2 irrigated; Sandy range site.

Blanket Series

The Blanket series consists of deep, well drained, nearly level soils on uplands. These soils formed in moderately alkaline, moderately fine textured loess and old alluvium.

In a representative profile the surface layer is dark grayish brown silt loam about 10 inches thick. The subsoil is about 42 inches thick. The upper 11 inches is dark grayish brown firm silty clay loam. The next 23 inches is firm grayish brown silty clay. The lower 8 inches is light brownish gray, firm silty clay loam. The underlying material is pale brown silty clay loam.

Permeability is moderately slow. Available water capacity is high, and natural fertility is high. The surface tends to crust after rains.

Blanket soils are well suited to dryland and irrigated crops and native or tame grasses commonly grown in the county. Major dryland crops are winter wheat, sorghum, and alfalfa (fig. 6). Irrigated corn and alfalfa are grown in places.

Representative profile of Blanket silt loam in a cultivated field, 1,260 feet east and 80 feet south of the northwest corner of sec. 12, T. 24 S., R. 12 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate medium granular structure; hard and friable; many roots; slightly acid; gradual smooth boundary.

B21t—10 to 21 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate medium subangular blocky structure; hard and firm; many roots; thin patchy clay films; slightly acid; gradual smooth boundary.

B22t—21 to 32 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate medium blocky structure; very hard and firm; many roots; thin continuous clay films; neutral; gradual smooth boundary.

B31ca—32 to 44 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) when moist; moderate medium subangular blocky structure; very

Figure 6.—**Cutting hard red winter wheat on Blanket silt loam near Stafford, Kansas.**

hard and firm; common roots; many fine and medium soft masses of lime and fine concretions; strongly effervescent; moderately alkaline; gradual smooth boundary.

B32ca—44 to 52 inches; light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) when moist; moderate fine subangular blocky structure; hard and firm; few roots; many fine and medium soft masses of lime and fine concretions; strongly effervescent; moderately alkaline; diffuse smooth boundary.

C—52 to 60 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) when moist; moderate fine granular structure parting to massive in the lower part; slightly hard and friable; few fine soft masses of lime and fine concretions; strongly effervescent; moderately alkaline.

The A horizon is typically dark grayish brown or grayish brown silt loam or silty clay loam 6 to 12 inches thick. The B2t horizon is mostly silty clay but is silty clay loam in places. It is 28 to 58 inches thick. The B3ca horizon is silty clay loam or clay loam. The C horizon is pale brown, brown, or yellowish brown silty clay loam or clay loam. Fine and medium soft masses of lime or lime concretions are at a depth of 28 to 44 inches.

Blanket soils are similar to Farnum soils. They are near Clark and Tabler soils and adjacent to small spots of clay soils in depressions and small spots of soils that have horizons high in content of sodium. Blanket soils have more clay in the B2t horizon than Farnum soils. Blanket soils have a clayey B2t horizon similar to that of Tabler soils, but they have a more gradual transition between the A and B2t horizons. Unlike Clark soils, Blanket soils do not have horizons that are high in content of lime.

Ba—Blanket silt loam. This nearly level soil is in broad convex areas.

Included with this soil in mapping are small areas of Farnum and Tabler soils. Also included are small areas of soils that have a high concentration of soft masses of lime and concretions in the subsoil. Others have a layer high in content of sodium.

Runoff is slow. Careful management of cultivated crops and crop residue is needed to control soil blowing, conserve moisture, and maintain soil tilth and fertility. Water erosion is a management concern on long slopes.

Most of the acreage of this soil is used for dryland and irrigated crops. Small areas are used for native grass pasture. Capability unit IIc-1 dryland and Class I irrigated; Loamy Upland range site.

Carwile Series

The Carwile series consists of deep, nearly level, slightly concave, somewhat poorly drained soils on uplands. These soils formed in stratified loamy eolian sediment or in loamy and clayey old alluvium.

In a representative profile the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsoil is about 31 inches thick. The upper 7 inches is dark grayish brown, friable sandy clay loam. The next 18 inches is light brownish gray, very firm sandy clay. The lower 6 inches is very pale brown, very firm, sandy clay. The underlying material is very pale brown sandy clay loam.

Permeability is slow. Available water capacity and natural fertility are high.

Carwile soils are well suited to dryland and irrigated crops, native and tame grasses, and trees and shrubs commonly grown in the county. Major crops are winter wheat, sorghum, and alfalfa. Irrigated corn, potatoes, and soybeans are grown in places.

Representative profile of Carwile fine sandy loam in a cultivated field, 1,680 feet north and 150 feet east of the southwest corner of sec. 30, T. 22 S., R. 11 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; slightly hard and friable; many fine roots; medium acid; gradual smooth boundary.

B1—7 to 14 inches; dark grayish brown (10YR 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) when moist; weak fine subangular blocky structure; hard and friable; many fine roots; slightly acid; gradual smooth boundary.

B2t—14 to 32 inches; light brownish gray (10YR 6/2) sandy clay; common medium distinct mottles of light brown (7.5YR 6/4), brown (10YR 5/3) when moist; moderate medium subangular blocky structure; very hard and very firm; common fine roots; clay films on many peds; neutral; gradual smooth boundary.

B3—32 to 38 inches; very pale brown (10YR 7/3) sandy clay; common medium distinct mottles of brownish yellow (10YR 6/6), pale brown (10YR 6/3) when moist; fine and medium subangular blocky structure; very hard and very firm; few roots; patchy clay films; mildly alkaline; gradual smooth boundary.

C—38 to 60 inches; very pale brown (10YR 7/3) sandy clay loam; many fine distinct mottles of brownish yellow (10YR 6/6) and common medium distinct mottles of light brown (7.5YR 6/4), pale brown (10YR 6/3) when moist; massive; hard and friable; slight effervescence; moderately alkaline, many fine calcium carbonate concretions.

The A horizon is grayish brown, dark grayish brown, or

brown and is 4 to 12 inches thick. It is typically fine sandy loam, but it is loam or loamy fine sand in places. The B horizon is 26 to 48 inches thick. The B1 horizon is dark grayish brown, brown, or dark brown sandy clay loam or loam. The B2t horizon is sandy clay, clay, or clay loam. It is light brownish gray, grayish brown, or brown. The B3 horizon is very pale brown, pale brown, or yellowish brown sandy clay, clay, or sandy clay loam. The C horizon is very pale brown, pale brown, yellowish brown, brownish yellow, strong brown, or reddish brown loamy or clayey sediment. It is commonly moderately alkaline and calcareous.

Carwile soils are similar to Tabler soils. They are near Attica, Farnum, Naron and Pratt soils. Carwile soils have less sand than Attica and Pratt soils. They are dark colored to lesser depth than Farnum and Tabler soils. Carwile soils have more clay in the B horizon than Farnum and Naron soils.

Ca—Carwile fine sandy loam. This nearly level soil has short to medium, slightly concave slopes. It has the profile described as representative of the series.

Included in places with this soil in mapping are small areas of Farnum, Naron, Pratt, and Tabler soils. Also included are some small areas of similar soils that have a subsoil high in content of lime. Other inclusions that are 1 to 3 acres in size and have layers high in sodium are indicated on the map by a spot symbol.

Runoff is slow, or the surface is ponded. Soil blowing is a concern of management. Careful management is needed to control soil blowing during dry seasons, conserve moisture, control ponding during wet seasons, and maintain soil tilth and fertility. Surface ponding is a management concern in low areas after periods of rain.

Most of the acreage of this soil is in dryland and irrigated crops. Major crops are winter wheat, sorghum, and alfalfa. Irrigated corn, potatoes, and soybeans are grown in places. Small areas are used for native range. Capability unit IIw-1 dryland and IIw-1 irrigated; Sandy range site.

Cw—Carwile complex. This complex consists of nearly level Carwile soils and soils having layers high in content of sodium. The soils in this complex are in an intricate pattern on short and medium concave slopes. They are near Carwile, Farnum, Naron and Tabler soils. Slopes are 0 to 1 percent.

This complex is 80 percent Carwile and similar soils, 10 percent soils having layers high in content of sodium and 10 percent small areas of Farnum soils and Naron fine sandy loam. Carwile fine sandy loam has the profile described as representative of the series.

Runoff is slow, or the surface is ponded. Soil blowing during periods of little rainfall and wetness during periods of much rainfall are concerns of management. The water table is seasonal. Crusting is severe if the soil is not protected by crops, crop residue, manure, or salt tolerant grasses. This crusting needs to be reduced, soil blowing needs to be controlled, and a protective cover of salt-tolerant crops or grasses to be established.

About half of the acreage of this soil is in dryland and irrigated crops. The rest is in native grass range. Capability unit IVs-2 dryland and IVs-2 irrigated; Sandy range site.

Clark Series

The Clark series consists of deep, gently sloping, well drained, calcareous soils on uplands. These soils formed in unconsolidated, highly calcareous, loamy old alluvium.

In a representative profile the surface layer is grayish brown loam about 8 inches thick. The next layer is light brownish gray, friable loam about 6 inches thick. The underlying material is pinkish gray loam that is about 40 percent soft masses and concretions of lime.

Permeability is moderate. Available water capacity is high, and natural fertility is high. The surface tends to crust after rainfall. These soils are susceptible to soil blowing.

Clark soils are well suited to dryland and irrigated crops and native and tame grasses commonly grown in the county. Major crops are winter wheat, sorghum, and alfalfa. Irrigated corn is grown in places. Sorghum is often affected by chlorosis.

Representative profile of Clark loam, 1 to 3 percent slopes, in a cultivated field, 990 feet west and 30 feet south of the northeast corner of sec. 33, T. 24 S., R. 11 W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate medium granular structure; hard and friable; many fibrous roots; strongly effervescent; moderately alkaline; clear wavy boundary.

AC—8 to 14 inches; light brownish gray (10YR 6/2) loam; dark grayish brown (10YR 4/2) when moist; moderate medium granular structure; hard and friable; many roots; many fine soft carbonate particles and fine concretions; many worm casts; violently effervescent; moderately alkaline; gradual wavy boundary.

Ca—14 to 60 inches; pinkish gray (7.5YR 7/2) loam, pinkish gray (7.5YR 6/2) when moist; moderate medium granular structure; hard, friable, few roots; soft masses of carbonates and carbonate concretions make up 40 percent of the volume; violently effervescent; moderately alkaline.

The A horizon is generally grayish brown or dark grayish brown loam or clay loam. It is 4 to 14 inches thick. The AC horizon is brown, light brownish gray, or brown loam 6 to 15 inches thick. The Cca horizon is very pale brown, pinkish gray, light yellowish brown, yellowish brown, or light brown. It is commonly loam but is clay loam in places. This horizon is calcareous and has many soft masses of lime.

Clark soils are near Blanket and Farnum soils. They lack the B horizon that is characteristic of Blanket and Farnum soils.

Cx—Clark loam, 1 to 3 percent slopes. This soil is gently sloping. It is on short and medium convex side slopes and ridges.

Included with this soil in mapping are similar soils that have a subsoil of clay loam and an underlying material that contains fewer soft masses of lime. Also included are a few small areas that have a surface layer of fine sandy loam.

Runoff is medium, and soil blowing is a concern of management. The large amounts of lime in the soil cause chlorosis in sorghum plants. Careful management is needed to control water erosion and soil blowing, conserve moisture, and maintain tilth and fertility.

Most of the acreage of this soil is in dryland and irrigated crops. Major crops are wheat, sorghum, and alfalfa. Small areas are used for native grass range in places. Capability unit IIIe-2 dryland and IIIe-2 irrigated; Limy Upland range site.

Dillwyn Series

The Dillwyn series consists of deep, nearly level to gently rolling, somewhat poorly drained soils on uplands. These soils formed in well sorted eolian sands.

In a representative profile the surface layer is grayish brown loamy fine sand about 8 inches thick. The next layer is pale brown, loose fine sand 20 inches thick. The underlying material is very pale brown fine sand.

Permeability is rapid. Available water capacity is low above the water table. The water table fluctuates from a depth of about 1 foot in wet seasons to a depth of 5 feet in dry seasons. Natural fertility is medium.

Dillwyn soils are well suited to native grasses, especially tall native grasses commonly grown in the county. They are not suited to cultivated crops.

Representative profile of Dillwyn loamy fine sand in an area of Dillwyn-Tivoli loamy fine sands, 0 to 15 percent slopes in grassland, 1,400 feet south and 2,440 feet east of the northwest corner of sec. 17, T. 21 S., 11 W.

A1—0 to 8 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak medium granular structure; soft and very friable; neutral; clear smooth boundary.

AC—8 to 28 inches; pale brown (10YR 6/3) fine sand, brown (10YR 4/3) when moist; common coarse distinct mottles of strong brown (7.5YR 5/6); single grained; loose both dry and moist; slightly acid; gradual smooth boundary.

C1—28 to 35 inches; very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) when moist; common coarse distinct mottles of reddish yellow (7.5YR 7/6); single grained; loose both dry and moist; medium acid; gradual smooth boundary.

C2—35 to 60 inches; very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) when moist; common coarse distinct mottles of reddish yellow (7.5YR 7/6); single grained; loose when dry or moist; medium acid.

The A horizon is grayish brown, very dark grayish brown, brown, or dark brown and is 4 to 10 inches thick. It is typically loamy fine sand, but is fine sand or fine sandy loam in places. The AC horizon is pale brown, light brownish gray, yellowish brown, brown, or grayish brown fine sand or loamy fine sand. It has few to common, fine to coarse reddish yellow or strong brown mottles. The C horizon is very pale brown, pale brown, brown, or light yellowish brown loamy fine sand or fine sand. It has common to many, medium to coarse, reddish yellow or strong brown mottles.

Dillwyn soils are similar to Pratt and Waldeck soils. They are near Plevna and Tivoli soils. Dillwyn soils contain more sand than Plevna and Waldeck soils. They are mottled and are wetter than Pratt and Tivoli soils.

Dp—Dillwyn-Plevna complex. This complex is on wind modified uplands. It has short and medium convex and concave slopes. Slope range is 0 to 5 percent.

This complex is about 60 percent Dillwyn loamy fine sand; 30 percent Plevna fine sandy loam and similar soils; and about 10 percent Carwile, Pratt, Tivoli and Zenda soils.

Dillwyn soils are gently rolling. They are on ridges and divides. Plevna soils are nearly level. They are in a slightly lower position. Pratt and Tivoli soils are in higher areas, while Carwile and Zenda soils are in slight depressions.

Plevna fine sandy loam of this complex has a profile described as representative of the Plevna series.

Runoff is very slow, and wetness is a concern of management. All soils in this complex except Pratt and Tivoli have a water table that fluctuates to within a few inches of the surface and drops to a depth of about 4 or 5 feet late in summer and early in autumn. Native grasses need to be maintained, and brush and trees need to be controlled.

Most of the acreage in this complex is in range. In places small areas are used for hay meadows. Other spots are used as stockwater pits. Capability unit Vw-2 dryland. Subirrigated range site.

Dt—Dillwyn-Tivoli loamy fine sands, 0 to 15 percent slopes. This complex is on wind modified uplands. It has short convex slopes that range from 0 to 15 percent.

This complex is about 65 percent Dillwyn loamy fine sand, 20 percent Tivoli loamy fine sand, 5 percent Tivoli fine sand, and about 10 percent Carwile and Plevna soils and Natrustolls.

Dillwyn soils are in nearly level areas, Tivoli soils are in rolling areas, and Natrustolls and Carwile and Plevna soils are in low areas.

The Dillwyn loamy fine sand of this complex has the profile described as representative of the series. The Tivoli loamy fine sand has a profile similar to the one described as representative of the series except the surface layer is loamy fine sand about 10 inches thick.

Runoff is very slow, and wetness is a concern when managing Dillwyn soils. Soil blowing can form blowouts on the Tivoli soils during dry seasons. Careful management is needed to maintain native grasses, control brush and trees, and control soil blowing.

Most of the acreage of this complex is used for range. Small areas are used as wildlife habitat. Capability unit VIe-2 dryland; Dillwyn soils in Subirrigated range site, Tivoli soils in Sands range site.

Farnum Series

The Farnum series consists of deep, nearly level, well drained soils on uplands. These soils formed in stratified, loamy old alluvium that has sand or clay layers in places.

In a representative profile the surface layer is grayish brown loam about 9 inches thick. The upper part of the subsoil is dark grayish brown, friable loam about 13 inches thick. The middle part is brown, firm clay loam 24 inches thick; and the lower part of the subsoil is brown, friable clay loam about 7 inches thick. The underlying material is yellowish brown loam.

Permeability is moderately slow. Available water capacity is high, and natural fertility is high.

Farnum soils are well suited to dryland and irrigated crops, native and tame grasses, and trees and shrubs commonly grown in the county. Major crops are winter wheat, sorghum, and alfalfa. Irrigated corn and soybeans are grown in places.

Representative profile of Farnum loam in a cultivated field, 1,815 feet south and 100 feet east of the northwest corner of sec. 10, T. 24 S., R. 12 W.

Ap—0 to 9 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; slightly hard and friable; many roots; medium acid; gradual smooth boundary.

B1—9 to 22 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate medium granular structure; slightly hard and friable; many roots; medium acid; gradual smooth boundary.

B21t—22 to 30 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; moderate fine subangular blocky structure; hard and firm; many roots; thin clay films on some peds; slightly acid; gradual smooth boundary.

B22t—30 to 38 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) when moist; moderate medium subangular blocky structure; hard and firm; many roots; distinct thin clay films; slightly acid; gradual smooth boundary.

B23t—38 to 46 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) when moist; moderate fine subangular blocky structure; hard and firm; common roots; distinct thin clay films; neutral; gradual smooth boundary.

B3—46 to 53 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; moderate medium granular structure; slightly hard and friable; common roots; neutral; gradual smooth boundary.

C—53 to 60 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) when moist; weak fine granular structure; slightly hard and friable; few roots; mildly alkaline.

The A horizon is grayish brown, dark grayish brown, or very dark grayish brown. It is typically loam but is very fine sandy loam in places. This horizon is 7 to 17 inches thick. The B horizon is grayish brown, dark grayish brown, very dark grayish brown, brown, or dark brown. It is 27 to 52 inches thick. The B2t horizon is clay loam, while the B3 horizon is clay loam or sandy clay loam. The C horizon is brown, pale brown, light yellowish brown, or yellowish brown loam, clay loam, sandy clay loam, or fine sandy loam.

Farnum soils are similar to Blanket and Naron soils. They are near Attica, Carwile, Clark, and Tabler soils. Farnum soils have less clay in the B2t horizon than Blanket, Carwile, and Tabler soils. They contain less sand than Attica and Naron soils and lack the high concentration of soft masses and concretions of lime that are characteristic of Clark soils.

Fa—Farnum fine sandy loam. This nearly level soil is in areas where slopes are medium and long and plane or convex. It has a profile similar to the one described as representative of the series except for a surface layer that is fine sandy loam and ranges from 11 to 17 inches in thickness. Slopes are 0 to 1 percent.

Included with this soil in mapping are small areas of Carwile fine sandy loam and Tabler loam. In some small areas layers are high in content of sodium, and the surface crust has little or no vegetation. These areas are indicated on the map by a spot symbol. Each symbol represents 1 to 3 acres.

Runoff is slow, and this soil absorbs water readily. Soil blowing is likely to occur unless the surface is protected by crops or crop residue. Careful management is needed, not only to control soil blowing but to conserve moisture and maintain soil fertility. Surface ponding after rainfall is a concern of management in small areas.

Most of the acreage of this soil is in dryland and irrigated crops. Small areas are in native grass range. Capability unit IIe-1 dryland and IIe-1 irrigated; Sandy range site.

Fr—Farnum loam. This nearly level soil has medium and long convex slopes. It has the profile described as representative of the series. The surface layer is 7 to 10 inches thick. Slopes are 0 to 2 percent.

Included in places with this soil in mapping are small areas of Carwile fine sandy loam and Tabler loam. Also included are small areas of a soil that has a high concentration of soft masses and concretions of lime in the lower part of the subsoil and in the underlying material. Other inclusions that have layers high in content of sodium and little or no vegetation are indicated on the map by a spot symbol. Each symbol represents 1 to 3 acres.

Runoff is slow to medium, and soil blowing is a concern of management. The surface of this soil needs to be protected by crops or crop residue. Careful management is needed to conserve moisture, control soil blowing and water erosion, and to maintain soil tilth and fertility. Water erosion is a concern of management on long slopes. Management is needed to control surface ponding after rainfall in low areas.

Most of the acreage of this soil is in dryland and irrigated crops. Other small areas are in native range. Capability unit IIc-1 dryland and Class I irrigated; Loamy Upland range site.

Kingman Series

The Kingman series consists of deep, nearly level, slightly depressional, poorly drained soils on broad flood plains along major streams. These soils formed in calcareous silty clay loam alluvium that is underlain by loamy layers at a depth of more than 40 inches.

In a representative profile the surface layer is gray silty clay loam about 18 inches thick. The subsoil is about 32 inches thick. The upper 22 inches is light gray, firm silty clay loam, and the lower 10 inches is light gray, firm silty clay loam that has soft masses and concretions of lime. The underlying material is very pale brown sandy loam.

Permeability is moderately slow. Available water capacity is very high, and natural fertility is high. The water table is at a depth of 6 inches to 2 feet. Kingman soils are subject to occasional flooding.

Most of the acreage of this soil is in range. Small areas are used as hay meadow, and other areas are used as stockwater pits.

Kingman soils are well suited to native grasses, especially the tall native grasses commonly grown in the county. They are not suited to cultivated crops.

Representative profile of Kingman silty clay loam in grassland, 1,980 feet north and 80 feet west of the southeast corner of sec. 22, T. 25 S., R. 12 W.

A11—0 to 10 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) when moist; moderate medium granular structure; hard and firm; many roots; violently effervescent; moderately alkaline; gradual smooth boundary.

A12—10 to 18 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) when moist; strong medium granular structure; hard and firm; many roots; violently effervescent; moderately alkaline; gradual smooth boundary.

B2g—18 to 40 inches; light gray (10YR 6/1) silty clay loam, common medium distinct mottles of light yellowish brown (10YR 6/4), grayish brown (10YR 5/2) when moist; moderate medium granular structure; hard, firm; common roots; common soft accumulations and concretions of lime; violently effervescent; moderately alkaline; smooth diffuse boundary.

B3g—40 to 50 inches; light gray (10YR 6/1) silty clay loam, medium distinct mottles of very pale brown (10YR 7/4), grayish brown (10YR 5/2) when moist; moderate fine granular structure; hard and firm; few roots; accumulations of lime in nearly white, soft, irregular masses; violently effervescent; moderately alkaline; gradual smooth boundary.

C—50 to 60 inches; very pale brown (10YR 7/3) sandy loam; many medium distinct mottles of reddish yellow (7.5YR 6/6), pale brown (10YR 6/3) when moist; massive; slightly effervescent; moderately alkaline.

The A horizon is 12 to 20 inches thick. It is gray, grayish brown, dark gray, or very dark grayish brown and is typically silty clay loam but is loam or clay loam in places. The B horizon is light gray, gray, or light brownish gray silty clay loam. The C horizon is very pale brown, pale brown, light brownish gray, gray, or light gray sandy loam, fine sandy loam, loam, silty clay loam, or clay loam.

Kingman soils are similar to Plevna and Zenda soils. They are near Natrustolls and small areas of Waldeck soils. Kingman soils contain less sand than Plevna, Waldeck, or Zenda soils. They lack the horizons that have the high salt content characteristic of those in Natrustolls.

Kg—Kingman silty clay loam. This nearly level soil is on long, slightly concave flood plains. Slopes are 0 to 1 percent. Included in places in mapping are small areas of Natrustolls.

Runoff is slow. This soil is wet and subject to occasional flooding. The water table is at a depth of about 6 inches during periods of high stream flow and drops to a depth of 2 feet during dry periods. Careful management is needed to maintain native grass cover and to control brush and trees.

Most of the acreage of this soil is in range. Small areas are in hay meadows, and others are used for stockwater pits. Capability unit Vw-3 dryland; Subirrigated range site.

Naron Series

The Naron series consists of deep, nearly level and gently sloping, well drained soils on uplands. These soils formed in loamy and sandy eolian deposits.

In a representative profile the surface layer is grayish brown fine sandy loam about 8 inches thick. The subsoil is 30 inches thick. The upper 5 inches is brown, friable fine sandy loam the middle 15 inches is brown, friable sandy clay loam, and the lower 10 inches is brown, friable, fine sandy loam. The underlying material is brown fine sandy loam.

Permeability is moderate. Available water capacity and natural fertility are high.

Naron soils are well suited to dryland and irrigated crops and to native or tame grasses grown in the county. Major crops are winter wheat, sorghum, and alfalfa. Corn and soybeans are grown in places.

Representative profile of Naron fine sandy loam in a cultivated field, 660 feet north and 270 feet west of the southeast corner of sec. 35, T. 23 S., R. 14W.

Ap—0 to 8 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; slightly hard and very friable; many roots; slightly acid; gradual smooth boundary.

B1—8 to 13 inches; brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak coarse prismatic breaking to weak medium subangular blocky structure; hard and friable; slightly acid, many fine roots; gradual smooth boundary.

B2t—13 to 28 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) when moist; moderate coarse prismatic structure breaking to moderate medium subangular blocky; very hard and friable; common fine roots; neutral; gradual smooth boundary.

B3—28 to 38 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak coarse prismatic structure parting to moderate medium granular; hard and friable; few roots; neutral; diffuse smooth boundary.

C—38 to 60 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard; friable; neutral.

The A horizon is grayish brown or dark grayish brown fine sandy loam 8 to 12 inches thick. The B1 horizon is grayish brown, dark grayish brown, or brown fine sandy loam or loam 5 to 10 inches thick. The B2t horizon is grayish brown, brown, pale brown or pinkish gray loam, sandy clay loam, or fine sandy loam 14 to 28 inches thick. The B3 and C horizons are light brown, brown, pale brown, or light yellowish brown fine sandy loam or loam. The C horizon is sandy clay loam or loamy sand in places. Silty and clayey layers are at a depth of more than 40 inches in many places.

Naron soils are similar to Attica and Farnum soils. They are near Pratt and Carwile soils. Naron soils have more clay in the B horizon than Attica and Pratt soils and contain less clay than Farnum or Carwile soils. They also are dark colored to a shallower depth than Farnum soils.

Na—Naron fine sandy loam. This nearly level and gently sloping soil is in a landscape of long and medium convex slopes (fig. 7). Included in mapping are small areas of Pratt and Carwile soils.

Runoff is slow. This soil will blow unless protected by crops or crop residue. Careful management is needed to control soil blowing, conserve soil moisture, and maintain soil fertility.

Most of the acreage of this soil is in dryland crops. Some fields are irrigated (fig. 8) and a few areas are in native grass and are used for grazing. Capability unit IIe-1 dryland and IIe-1 irrigated, Sandy range site.

Natrustolls

(Nu) Natrustolls — are on low terraces of major streams. Mapped areas are 85 percent Natrustolls and soils similar to Natrustolls and 15 percent small areas of Kingman, Plevna, Waldeck and Zenda soils. The soils in this unit are variable. In general Natrustolls are loamy throughout, but some consist of loamy material over sandy material or clayey material over sandy material. Most commonly, the surface layer is grayish brown fine sandy loam, loam, or clay loam

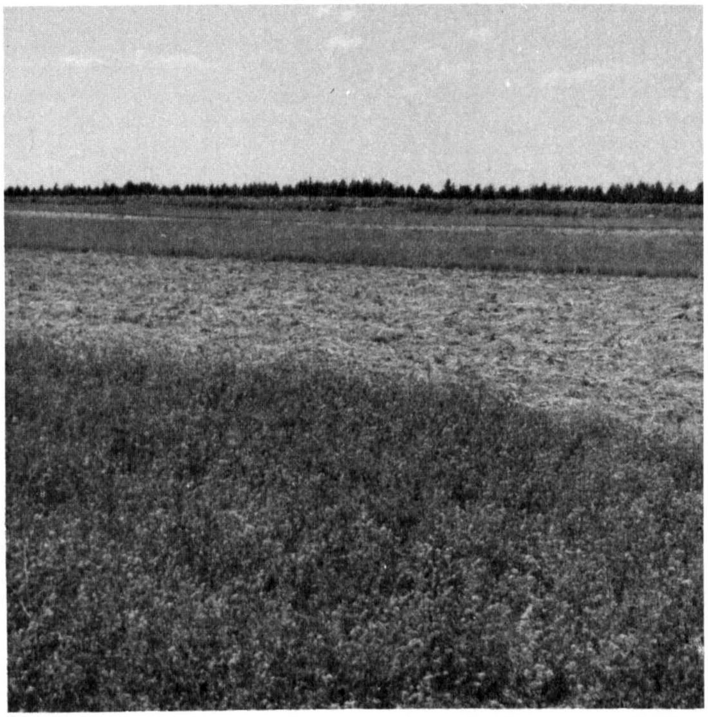

Figure 7.—Alfalfa and wheat stubble mulch on Naron fine sandy loam.

Figure 8.—Gravity irrigated corn on Naron soils.

5 to 10 inches thick. The subsoil is clay loam or sandy clay loam 5 to 20 inches thick and contains various amounts of salts and sodium. Nests of salts are common. The underlying material is dominantly fine sandy loam or clay loam, but in many places sandy or clayey layers are below a depth of 40 inches.

Permeability is typically moderately slow, but in small areas it ranges from slow to moderately rapid. Available water capacity is moderate, and natural fertility is low. These soils are somewhat poorly drained and are subject to occasional flooding. They have a seasonal high water table at a depth of 2 to 6 feet.

Natrustolls are used mostly for range. Small areas are used for cultivated crops. Natrustolls are well suited to native grasses and are poorly suited to cultivated crops. Wetness, flooding, and excess salts are concerns of management. Capability unit VIs-1; Saline Subirrigated range site.

Plevna Series

The Plevna series consists of deep, nearly level to sloping poorly drained soils on flood plains. These soils formed in loamy alluvium underlain in many places by sandy or clayey alluvium.

In a representative profile the surface layer is dark grayish brown fine sandy loam about 12 inches thick. The subsoil is mottled, grayish brown, friable and very friable fine sandy loam about 26 inches thick. The underlying material is pale brown fine sand.

Permeability is moderately rapid above the water table. These soils have a seasonally high water table that is within a few inches of the surface during wet seasons and drops to a depth of about 4 feet late in summer and early in autumn. Available water capacity is moderate, and natural fertility is high.

Plevna soils are well suited to native grasses. They are not suited to cultivated crops. They are used mainly for range, but small areas are in hay meadow.

Representative profile of Plevna fine sandy loam in an area of Dillwyn-Plevna complex in grassland, 1,980 feet north and 1,020 feet east of the southwest corner of sec. 33, T. 22 S., R. 11 W.

A1—0 to 12 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; slightly hard and friable; many fine roots; neutral; gradual smooth boundary.

B21g—12 to 24 inches; grayish brown (10YR 5/2) fine sandy loam; common fine distinct mottles of pale brown (10YR 6/3) and gray (10YR 5/1); dark grayish brown (10YR 4/2) when moist; moderate medium granular structure; slightly hard and friable; common fine roots; neutral; gradual smooth boundary.

B22g—24 to 38 inches; grayish brown (10YR 5/2) light fine sandy loam; common fine distinct mottles of light yellowish brown (10YR 6/4) and gray (10YR 5/1); dark grayish brown (10YR 4/2) when moist; weak fine granular structure; slightly hard, very friable; few fine roots; neutral; gradual smooth boundary.

IIC—38 to 60 inches; pale brown (10YR 6/3) fine sand; few fine faint mottles of brownish yellow (10YR 6/6); brown (10YR 5/3) when moist; massive; soft and very friable; mildly alkaline.

The A horizon is dark grayish brown, grayish brown, gray, or dark gray fine sandy loam 10 to 18 inches thick. It is loamy fine sand in places. The Bg horizon is grayish brown, light brownish gray, light gray, or gray fine sandy loam 20 to 40 inches thick. The C horizon is commonly fine

sand, but in places it is loamy or clayey at depths below 40 inches.

Plevna soils are similar to Kingman and Waldeck soils. They are near Dillwyn, Natrustolls, Pratt, Tivoli, and Zenda soils. Plevna soils are more poorly drained than Waldeck soils, and runoff is slower on Plevna soils. They contain more sand than Kingman, Natrustolls, and Zenda soils and less sand than Dillwyn, Pratt, and Tivoli soils.

Pa—Plevna soils. These nearly level, slightly depressional soils are on flood plains of perennial streams. Slopes are 0 to 1 percent.

Included with these soils in mapping are small areas of Pratt and Zenda soils.

Runoff is very slow, and wetness is a concern of management. The water table is within a few inches of the surface during wet seasons and drops to a depth of about 4 feet late in summer and early in autumn. The soils in this mapping unit are generally flooded more than once a year. Careful management is needed to maintain native grasses, control brush and scrub trees, and improve runoff.

Most of the acreage of these soils is used for range. Some small areas are used as hay meadows, and others are used for stockwater pits. Capability unit Vw-1 dryland; Subirrigated range site.

Pc—Plevna soils, channeled. These soils are on low, channeled flood plains of perennial streams in areas 200 to 500 feet wide. They formed in highly stratified, loamy and sandy recent alluvium. Slopes are 3 to 15 percent. The surface layer is typically fine sandy loam but is loamy fine sand in places.

This mapping unit is 90 percent Plevna and similar soils; 5 percent stream channels, stream banks, gravel, and sand bars; and 5 percent Waldeck and Zenda soils in small areas on natural stream levees and outlying areas of the flood plain.

This mapping unit is usually flooded more than 3 times a year. Careful management is needed to maintain native grasses, control brush and scrub trees, and reduce channel erosion and deposition.

Most of the acreage of these soils is range. Stockwater pits are seldom established because of frequent flooding. Capability unit VIw-I dryland; Subirrigated range site.

Pratt Series

The Pratt series consists of deep, undulating to rolling well drained soils on uplands. These soils formed in sandy eolian sediment.

In a representative profile the surface layer is grayish brown loamy fine sand about 8 inches thick. The subsoil is strong brown, very friable, heavy loamy fine sand about 20 inches thick. The underlying material is light yellowish brown loamy fine sand.

Permeability is rapid. Available water capacity is low, and natural fertility is medium.

Pratt soils are suited to dryland and irrigated crops and to native and tame grasses commonly grown in the county. Major crops are winter wheat and sorghum. Irrigated corn and dryland and irrigated alfalfa are grown in places.

Representative profile of Pratt loamy fine sand, hummocky, in a windbreak; 1,500 feet west and 10 feet north of the southwest corner of sec. 21, T. 22 S., R. 12 W.

A1—0 to 8 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak fine granular structure; soft and very friable many fine roots; slightly acid; gradual smooth boundary.

B2t—8 to 28 inches; strong brown (7.5YR 5/6) heavy loam fine sand, brown (7.5YR 4/4) when moist; moderate coarse prismatic structure parting to weak medium granular; hard and very friable; common fine roots; slightly acid; diffuse boundary.

C—28 to 60 inches; light yellowish brown (10YR 6/4) loamy fine sand, dark yellowish brown (10YR 4/4) when moist; structureless; loose; few fine roots; slightly acid.

The A horizon is grayish brown, dark grayish brown or brown loamy fine sand 6 to 14 inches thick. The B2t horizon is strong brown, brown, or yellowish brown heavy loamy fine sand 15 to 36 inches thick. The C horizon is brown, light brown, light yellowish brown, or pale brown loamy fine sand or loamy sand.

Pratt soils are similar to Albion, Attica, Dillwyn, and Tivoli soils. They are near Carwile, Farnum, and Naron soils. Pratt soils have more sand in the B horizon than Albion, Attica, Carwile, Farnum, and Naron soils. They are less sandy than Tivoli soils. Unlike Dillwyn soils, Pratt soils are not saturated part of the year.

Ph—Pratt loamy fine sand, hummocky. This soil is on wind modified uplands. It has short and medium length convex slopes that range from 5 to 10 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Attica, Carwile, Farnum, Naron, and Tivoli soils. Also included are small areas of intermittent lakes and depressions. Underlying layers in these areas are clayey, loamy, and sandy. Most depressions are indicated on the map by a spot symbol. Each symbol represents about 2½ acres.

Runoff is slow, and soil blowing is a concern of management. Careful management of cultivated crops and crop residue is needed to control soil blowing, conserve moisture, and maintain soil fertility. Careful management of range is needed to control soil blowing.

Most of the acreage of this soil is range. In places fields are in dryland crops or irrigated crops. Capability unit IVe-1 dryland and IIIe-1 irrigated; Sands range site.

Po—Pratt loamy fine sand, undulating. This soil is on wind modified sandy uplands. It has medium length convex slopes that range from 1 to 5 percent.

Included with this soil in mapping are similar soils that have a subsoil of fine sandy loam or light fine sandy loam; small areas of Attica, Carwile, Farnum, and Naron soils; and, in places small areas of intermittent lakes and depressions. Gray clayey layers and loamy layers underlain by sand are in the areas of intermittent lakes and depressions. Most of the depressions are indicated on the map by a spot symbol. Each symbol represents about 2½ acres.

Runoff is slow, and soil blowing is a concern of management. Careful management is needed to control soil blowing, conserve moisture, and maintain soil fertility. Ponding in areas of intermittent lakes and de-

pressions is a minor concern of management.

Most of the acreage of this soil is cultivated crops, but small areas are used for range. Major crops are winter wheat, sorghum, and alfalfa. Irrigated corn is grown in places. Capability units IIIe-1 dryland and IIIe-1 irrigated; Sands range site.

Pr—Pratt-Carwile complex, 0 to 8 percent slopes. This complex is on wind modified uplands. It has short and medium length convex slopes.

This complex is 50 percent Pratt loamy fine sand and similar soils; 35 percent Carwile fine sandy loam and similar soils; and 15 percent Attica, Farnum, Naron, and Tabler soils in small areas.

Pratt and Attica soils are undulating. They are on hummocks. These soils have profiles similar to those described as representative of their respective series. Naron soils are gently sloping, and Carwile, Farnum, and Tabler soils are nearly level and are in low areas.

The soils similar to the Pratt soil have a surface layer of grayish brown or brown loamy fine sand and a subsoil of brown fine sandy loam. The underlying material is yellowish brown loamy fine sand. The soils similar to the Carwile soil have a surface layer of grayish brown loamy fine sand and a subsoil of light brownish gray or gray clayey material. The underlying material of these soils is loamy or clayey.

Runoff is slow, and soil blowing and ponding are concerns of management. Water stands in low areas for long periods after rainfall. Soil blowing needs to be controlled, low areas need to be drained, moisture needs to be conserved (especially where slopes are undulating), and soil fertility needs to be maintained.

Most of the acreage of this complex is in cultivated crops. Small areas are in range. Major crops are winter wheat, sorghum, and alfalfa. Irrigated corn is grown in places. Capability unit IIIe-1 dryland and IIIe-1 irrigated; Pratt soil in Sands range site, Carwile soil in Sandy range site.

Pt—Pratt-Tivoli loamy fine sands, hummocky. This complex is on wind modified sandy uplands. It has short convex slopes that range from 5 to 15 percent.

This complex is 65 percent Pratt loamy fine sand; 25 percent Tivoli loamy fine sand; 5 percent Tivoli fine sand; and 5 percent Carwile, Dillwyn, and Tabler soils in small areas.

Pratt and Tivoli soils are on hummocks, and Carwile, Dillwyn, and Tabler soils are in low areas. The Tivoli loamy fine sand has a profile similar to the one described as representative of the series, except the surface layer is loamy fine sand about 10 inches thick.

Runoff is slow, and soil blowing is a concern of management. Very careful management is needed to maintain a good native grass cover that will protect these soils from blowing.

All of the acreage of this complex is used for range. Capability unit VIe-1 dryland and IVe-1 irrigated; Sands range site.

Tabler Series

The Tabler series consists of deep, moderately well drained, nearly level soils on uplands. These soils formed in loamy and clayey old alluvium.

In a representative profile the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is 31 inches thick. The upper 16 inches is dark gray, very firm silty clay, and the lower 25 inches is grayish brown, very firm clay. The underlying material is light gray clay.

Permeability is very slow. Available water capacity is high, and natural fertility is high.

Tabler soils are well suited to dryland crops and native or tame grasses commonly grown in the county. They are moderately well suited to irrigated crops. Major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Tabler loam, cultivated, 610 feet north and 100 feet west of the southeast corner of sec. 23, T. 21 S., R. 13 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard and friable; many fine roots; slightly acid; clear smooth boundary.

B21t—7 to 23 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; moderate fine blocky structure; very hard and very firm; common fine roots; clay films on nearly all peds; slightly acid; gradual smooth boundary.

B22t—23 to 33 inches; grayish brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate medium blocky structure; extremely hard and very firm; clay films on nearly all peds; few fine roots; mildly alkaline; gradual smooth boundary.

B3—33 to 48 inches; grayish brown (10YR 5/2) clay; common medium distinct mottles of equal proportions of black (N 2/0) and brown (7.5YR 5/4); dark grayish brown (10YR 4/2) when moist; moderate medium subangular blocky structure; very hard and very firm; patchy clay films; slightly effervescent; moderately alkaline; gradual smooth boundary.

C—48 to 60 inches; light gray (10YR 7/2) clay; common fine distinct mottles of light brown (7.5YR 6/4); grayish brown (10YR 5/2) when moist; massive; hard and firm; violently effervecent; moderately alkaline; many fine concretions.

The A horizon is dark grayish brown, grayish brown, dark gray, or very dark grayish brown. It is typically loam but is clay loam or silt loam in places. This horizon is 5 to 12 inches thick. The B2t horizon is 13 to 26 inches thick. The B21t horizon and B22t horizon are silty clay or clay. The B3 horizon is silty clay or clay 9 to 17 inches thick. It is silty clay loam or clay loam in places. The C horizon is light gray, gray, light brownish gray, grayish brown, or pale brown clay, silty clay loam, or clay loam. Fine lime concretions are at a depth of 27 to 38 inches.

Tabler soils are near Blanket, Carwile, and Farnum soils. Tabler soils have more clay in the B horizon than Farnum soils. They have a thinner transition between the A and B2t horizons than Blanket or Carwile soils.

Ta—Tabler loam. This nearly level soil is on medium and long, slightly concave upland slopes. Slopes are 0 to 1 percent.

Included in places with this soil in mapping are small areas of Blanket, Carwile, and Farnum soils. Also included are small areas of soils that have a subsoil high in content of lime and other small areas of soils that have layers high in content of sodium.

Runoff is slow, or the surface is ponded. The surface layer crusts when dry, and water movement through the subsoil is very slow. This soil is likely to blow unless protected by crops or crop residue. Careful management is needed to control soil blowing, improve surface drainage, and maintain soil tilth and fertility.

Surface ponding and very slow permeability are concerns of management.

Most of the acreage of this soil is used for cultivated crops. Major crops are winter wheat, sorghum, and alfalfa. Irrigated sorghum and corn are grown in places. Other small areas are in native grass used for range. Capability unit IIs-1 dryland and IIs-1 irrigated; Clay Upland range site.

Tivoli Series

The Tivoli series consists of deep, excessively drained, undulating to hilly soils on uplands. These soils formed in sandy eolian sediment.

In a representative profile the surface layer is brown fine sand about 6 inches thick. The underlying material is light yellowish brown fine sand.

Permeability is rapid. Available water capacity is low, and natural fertility is low.

Tivoli soils are suited to native grasses commonly grown in the county.

Representative profile of Tivoli fine sand, hilly, in grassland, in the E ½ of NW ¼ of NW ¼ of sec. 25, T. 22 S., R. 12 W.

A1—0 to 6 inches; brown (10YR 5/3) fine sand, dark brown (10YR 4/3) when moist; single grained; loose; common roots; slightly acid; gradual smooth boundary.

C—6 to 60 inches; light yellowish brown (10YR 6/4) fine sand, yellowish brown (10YR 5/4) when moist; single grained; loose; few fine roots; slightly acid.

The A horizon is brown, grayish brown, light brownish gray, pale brown, light yellowish brown, or yellowish brown fine sand 4 to 8 inches thick. It is loamy fine sand in places. The C horizon is brown, yellowish brown, pale brown, light yellowish brown, or brownish yellow fine sand. Layers of coarse sand, gravel, or loamy material are at a depth of 40 inches or more in places.

Tivoli soils are near Attica, Carwile, Dillwyn, Plevna, and Pratt soils. They contain more sand than Attica, Carwile, Dillwyn, Plevna, or Pratt soils.

Tv—Tivoli fine sand, hilly. This soil is on wind modified sandy uplands. It has short convex slopes that range from about 5 to 20 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Pratt and Carwile soils. Also included are small areas of a soil that has calcareous fine sand and loamy fine sand underlying material.

Runoff is slow, and soil blowing is a concern of management. Careful management is needed to maintain native grass cover in good condition and to control soil blowing.

This soil is native grass range. Capability unit VIIe-1 dryland; Choppy Sands range site.

Waldeck Series

The Waldeck series consists of deep, nearly level, somewhat poorly drained soils on flood plains and low terraces. These soils formed in loamy alluvium.

In a representative profile the surface layer is grayish brown and dark grayish brown fine sandy loam 12 inches thick. The next layer is grayish brown, friable fine sandy loam about 8 inches thick. The underlying material, to a depth of 30 inches, is brown fine sandy loam. Below this it is pale brown fine sand.

Permeability is moderately rapid above the water table. These soils have a seasonally high water table. Available water capacity is moderate, and natural fertility is high.

Waldeck soils are well suited to dryland crops and trees and native and tame grasses commonly grown in that county. Major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Waldeck fine sandy loam in a cultivated field, 1,650 feet west and 150 feet south of the northwest corner of sec. 29, T. 23 S., R. 13 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; slightly hard and very friable; many fine roots; mildly alkaline; gradual smooth boundary.

A12—6 to 12 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; slightly hard and very friable; many fine roots; mildly alkaline; gradual smooth boundary.

AC—12 to 20 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate fine granular structure; slightly hard and friable; common fine roots; slightly effervescent; mildly alkaline; gradual smooth boundary.

C1—20 to 30 inches; brown (10YR 5/3) light fine sandy loam; common medium distinct mottles of yellowish brown (10YR 5/4) and common fine distinct mottles of gray (10YR 6/1), dark brown (10YR 4/3) when moist; moderate fine granular structure; slightly hard and very friable; few fine roots; strongly effervescent; moderately alkaline; diffuse boundary.

C2—30 to 60 inches; pale brown (10YR 6/3) fine sand with few fine faint mottles of yellowish brown (10YR 5/4); brown (10YR 5/3) when moist; single grained; loose; strongly effervescent; moderately alkaline.

The A horizon is grayish brown, dark grayish brown, dark gray, or gray fine sandy loam 10 to 20 inches thick. It is loam in places. The AC and C1 horizons are sandy loam or fine sandy loam and have a combined thickness of 14 to 40 inches. The C2 horizon is grayish brown, light brownish gray, pale brown, brown, light yellowish brown, or yellowish brown fine sand or loamy fine sand.

Waldeck soils are similar to Plevna and Zenda soils. They are near Dillwyn and Kingman soils and Natrustolls. Waldeck soils contain less sand than Dillwyn soils and more sand than Kingman and Zenda soils or Natrustolls. They are less saline than Natrustolls. Waldeck soils are not so wet as Plevna soils.

Wa—Waldeck fine sandy loam. This nearly level soil is on short and medium low terraces and flood plains adjacent to major streams. Slopes are 0 to 1 percent.

Included with this soil in mapping are small areas of Zenda soils. Some small areas of well drained, less frequently flooded soils and soils that have a finer texture below the surface layer are also included.

Runoff is slow, and this soil is subject to flooding during periods of heavy rainfall. The water table fluctuates between depths of 2 and 6 feet. Careful management of cultivated crops and crop residue is needed to control soil blowing and to maintain soil fertility.

Most of the acreage of this soil is used for dryland

crops. In places small areas are used for range. Capability unit IIIw-1 dryland and IIIw-1 irrigated; Subirrigated range site.

Zenda Series

The Zenda series consists of deep, nearly level, somewhat poorly drained soils on low stream terraces. These soils formed in loamy, calcareous alluvium.

In a representative profile the surface layer is grayish brown loam about 20 inches thick. The underlying material, to a depth of 54 inches, is mottled, pale brown loam. Below this it is pale brown loamy fine sand.

Permeability is moderate. Available water capacity is high, and natural fertility is medium. These soils are subject to occasional flooding and have a seasonally high water table at a depth of 2 to 6 feet.

Zenda soils are well suited to dryland crops, trees, and native and tame grasses commonly grown in the county. Major crops are winter wheat, sorghum, and alfalfa.

Representative profile of Zenda loam in an area of Zenda-Natrustolls complex in grassland, 1,830 feet north and 150 feet east of the southwest corner of sec. 21, T. 23 S., R. 13 W.

A11—0 to 5 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; hard and friable; many fine roots; mildly alkaline; gradual smooth boundary.

A12—5 to 20 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; hard and friable; many fine roots; moderately alkaline; strongly effervescent; gradual smooth boundary.

C1—20 to 54 inches; pale brown (10YR 6/3) loam and common medium distinct mottles of light brown (7.5YR 6/4), brown (10YR 5/3) when moist; weak fine granular structure; hard, friable; few fine roots; violently effervescent; moderately alkaline; fine soft masses of lime and fine concretions; gradual smooth boundary.

C2—54 to 60 inches; pale brown (10YR 6/3) loamy fine sand and common medium distinct mottles of reddish yellow (7.5YR 6/6), brown (10YR 5/3) when moist; massive; slightly hard and very friable; strongly effervescent; moderately alkaline.

The A horizon is grayish brown, dark grayish brown, gray, dark gray, dark brown, or brown loam 10 to 20 inches thick. It is clay loam or fine sandy loam in places. The C horizon is pale brown, light brownish gray, grayish brown, brown, light brown, strong brown, light yellowish brown, or yellowish brown loam. It is clay loam in places. In places the C horizon has layers of fine sandy loam and loamy fine sand at a depth of less than 40 inches.

Zenda soils are similar to Waldeck and Plevna soils and Natrustolls. They are near Kingman soils. They contain less sand than Waldeck and Plevna soils and more sand than Kingman soils. Zenda soils lack the natric horizons or horizons high in content of that characteristic of Natrustolls.

Za—Zenda-Natrustolls complex. This nearly level complex is on short and medium length low terraces of major streams. Slopes are 0 to 1 percent.

This complex is 75 percent Zenda loam and similar soils; 15 percent Natrustolls; and 10 percent Carwile, Kingman, and Plevna soils in small areas.

Natrustolls in this complex have characteristics similar to those described as representative of the soils in the Natrustolls unit.

Runoff is slow, and flooding of short duration can be expected at least once each year. The water table fluctuates in sandy layers from a depth of 2 to 6 feet. These soils will blow if they are not protected by crops, crop residue, or good stands of native and tame grasses. The main management needs are providing a good protective cover by growing grasses or trees and maintaining soil fertility where the soils are saline. Capability unit IVs-1 dryland and IVs-1 irrigated; Zenda soil in Subirrigated range site, Natrustolls in Saline Subirrigated range site.

Planning the Use and Management of the Soils

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area—the soil. It may be used to fit the use of the land, including urbanization, to the limitations and potentials of the natural resources and the environment, and to help avoid soil related failures in uses of the land.

During a soil survey soil scientists, conservationists, engineers, and others keep extensive notes, not only about the nature of the soils but also about unique aspects of behavior of these soils in the field and at construction sites. These notes include observations of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating the kinds of soil and their productivity, potentials, and limitations under various uses and management. In this way field experience and measured data of soil properties and performance are used as a basis for predicting the behavior of the soils.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for cultivated crops and pasture, range, and woodland. The information will also be useful for many nonfarm uses, including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses is determined, soil limitations to these land uses is identified, and costly failures in homes and other structures, because of unfavorable soil properties, may be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Both of these factors are closely related to the nature of the soil. Plans can be made to maintain or create a land use pattern in harmony with the natural soil.

Contractors can find information useful in locating sources of sand and gravel, road fill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and

other specialists can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, trees and shrubs, and most other uses of land are influenced by the nature of the soil.

Management of Soils for Dryland Crops[2]

Wheat, grain sorghum, and alfalfa are the major crops grown in Stafford County. Forage sorghum, corn, and truck crops are also grown. The sequence of crops affects the combination of practices needed on a particular soil. A closely spaced crop such as wheat provides more protection for the soil than a widely spaced crop such as sorghum. Also, crop residue from wheat fields provides more protection than the more coarse residue derived from grain sorghum.

Stripcropping can be used to control soil blowing. It is suited to nearly all of the soils in the county except some nearly level silt loams on uplands, some nearly level soils on flood plains, and hilly, sandy soils on uplands. Applying manure and returning crop residue to the soil help to maintain organic matter, natural soil fertility, and tilth.

Careful management of crop residue is needed on all of the soils used for cultivated crops in Stafford County to maintain good soil structure, promote infiltration of water, and control soil blowing and water erosion. A cover of crop residue on the surface helps hold the soil in place, increases the amount of water intake, and helps reduce the effect of beating raindrops and subsequent puddling. Increasing the amount of water that penetrates the soil surface on higher areas of the landscape helps reduce the amount of runoff into lower ponded areas.

Minimum or reduced tillage helps prevent the breakdown of soil aggregates and maintains more residue on the surface. Tillage of soils that have a loamy or clayey subsoil when too wet tends to cause the development of a tillage pan to a greater degree than on sandy soils.

Terracing and contour farming can be used to reduce water erosion and help conserve rainfall on nearly all of the soils having single, nearly level and gentle slopes. They are not generally applicable to soils that have complex slopes. These soils are more commonly managed by using stripcropping. Terraces, contour farming, and stripcropping tend to save water for increased crop growth and add to the amount of crop residue available to protect the soil.

Some areas of the county, mainly along Rattlesnake Creek, contain a sufficient amount of salts to adversely affect the growth of plants. Natrustolls, for example, have horizons high in exchangeable sodium (fig. 9). These salts formed in old alluvial deposits and have weathered and moved about in the soil and in fluctuating water tables.

The chemical composition of salt-affected soils varies.

[2]EARL BONDY, conservation agronomist, Soil Conservation Service, assisted in writing this section.

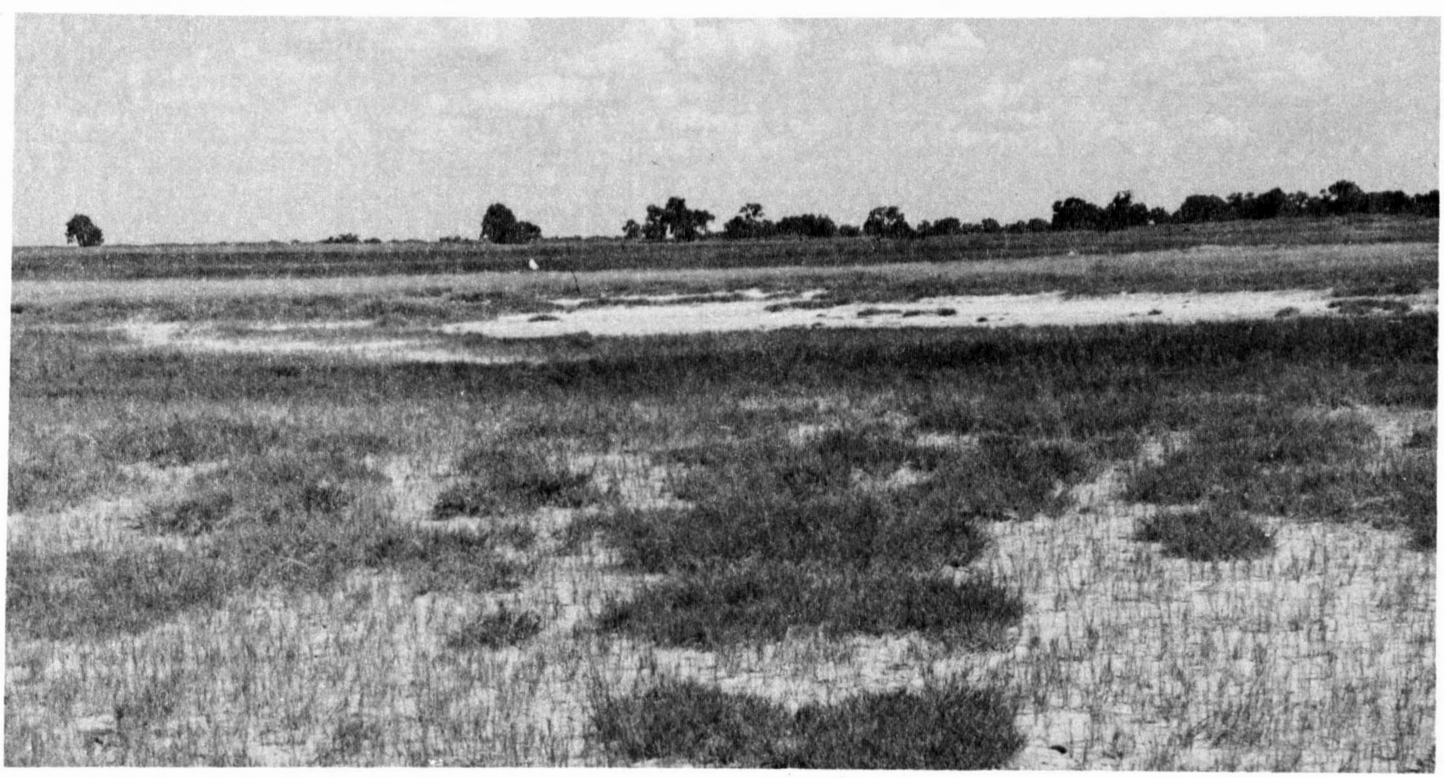

Figure 9.—A severe salt-affected area of native grassland near Rattlesnake Creek.

The composition of each individual salt-affected area is not easily predicted and requires separate analysis to properly identify the type and amount of salt present. When the nature and composition of these areas are known, gypsum or other soil amendments may be used if good drainage has been established in the surface layer and subsoil, use of the moldboard plow has been discontinued, and crop residue is properly managed. Other practices that tend to break up the crust of the salt-affected area and promote leaching of salts and sodium below the root zone are necessary in cultivated fields.

Salt tolerant crops and grasses such as wheat, rye, bermudagrass, western wheatgrass, alkali sacaton, and inland saltgrass are used to maintain plant cover and for production.

Management of Soils for Irrigated Crops[3]

Major management needs of the irrigated soils in Stafford County are use of irrigation water efficiently, control of soil blowing, maintenance of soil tilth and fertility, and control of erosion and runoff. Soil tilth and fertility can be maintained by using commercial fertilizers and manure, by making proper use of crop residue, and by using a cropping sequence that includes deep rooted legumes. Practices that increase content of organic matter and avoid compacting of the soil also help to improve soil tilth. Deep rooted legumes increase the percolation of water and the movement of air in lower soil horizons.

Most of the irrigation in Stafford County is done by sprinklers (fig. 10). Surface irrigation also is used in places. A well designed sprinkler or surface irrigation system is needed to conserve water, reduce erosion, control tailwater, and avoid salt damage to soils. When planning an irrigation system make sure that water quality is suitable when applied to the soil; consider the kind of soil in relation to its permeability and natural soil drainage; make sure that the quantity of water is adequate; choose the type of system best suited to the soil and to the slope of the soil; and prepare for the management of the soil and equipment prior to, during, and between irrigations.

Sand and gravel beds of the Meade formation are the most important source of irrigation water in Stafford County (*9*). This formation yields moderately hard water and in most places is good quality water.

Irrigated crops are grown on all but the hilly areas of the county. Major crops are corn, grain sorghum, alfalfa, and wheat. Soybeans have been grown at the Sandyland Experimental Field and other places in the county. Irrigated truck crops also can be grown on most of the soils of the county. Irish potatoes of good quality have been produced on Pratt soils in fields near St. John.

[3]LAWRENCE N. NIEMAN, district conservationist, and LARRY C. DOUD, technician, Soil Conservaton Service, assisted in writing this section.

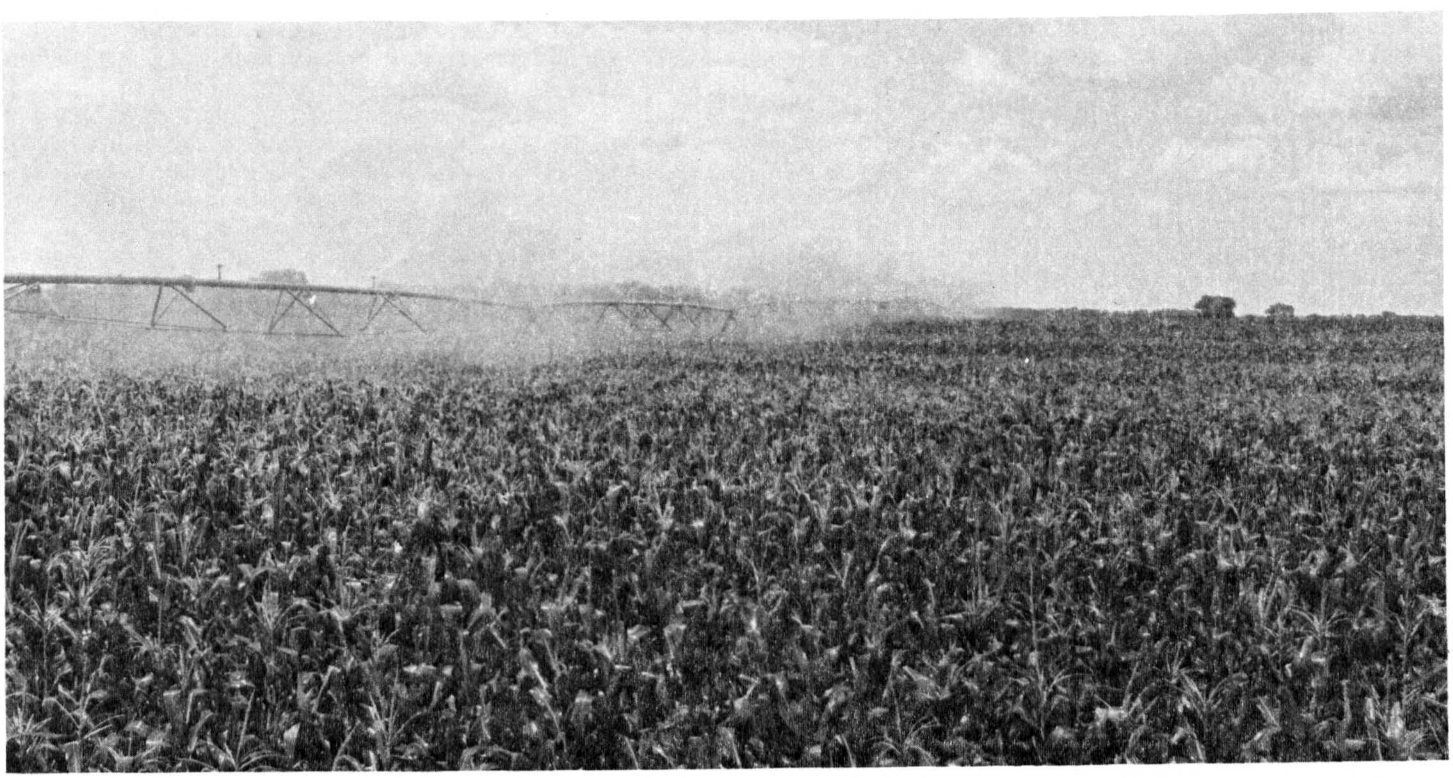

Figure 10.—Sprinkler irrigated corn on Naron and Carwile soils.

Capability grouping

Some land users, particularly those who farm large areas, may find it practical to use and manage alike some of the different kinds of soils. The capability classification system groups together the different kinds of soil that have some similar characteristics. Each group, in a general way, shows the suitability to dryland or irrigated crops.

Capability grouping is based on permanent limitations of the soil if it is used for commonly known field crops, the risk of damage if cultivated, and the way the soils respond to treatment. It does not take into account major landforming practices that would change slope, depth, or other characteristics of the soil; does not apply to major reclamation projects; and does not apply to exotic crops, for which management is unknown or for crops that require special management.

The capability classification system can be used to infer something about the behavior of soils if used for other purposes, but it is not a substitute for interpretations designed to show suitability to and limitations for engineering, range, windbreaks, wildlife habitat, or recreation.

In the capability system all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the *capability class*, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage if they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and land forms so rough, shallow, or otherwise limited that they cannot produce worthwhile yields of crops, forage, or wood products. There are no class VIII soils in Stafford County. The *subclass* indicates the major kind of limitation within the class. Each class can have up to four subclasses. The subclass is noted by a small letter, *e*, *w*, *s*, or *c* following the class numeral, for example IIe. The letter *"e"* indicates soils susceptible to erosion or that have been damaged by erosion; *"w"* indicates soils that are somewhat poorly drained or poorly drained, that have a high water table, or are flooded; *"s"* indicates soils that are shallow or stony, that have very low or low available water capacity, very slow permeability, low natural fertility, or are saline or alkaline; and *"c"* indicates that the chief limitation is climate, considering that the soil would be more productive if less dry or warmer.

Subclasses are further divided into interpretive groups called *capability units*. These are groups of soils so much alike that they are suited to the same commonly grown crops and tame pasture plants, require about the same management for the commonly grown crops and tame pasture plants, and have generally similar productivity and response to management. Capability units are identified by Arabic numbers assigned locally, for example IIe-1 or IVs-2.

Seven classes of the capability system and the subclasses and units in Stafford County are described in the list that follows. The unit designation is given in the "Guide to Mapping Units."

Class I soils have few limitations that restrict their use.

Unit I (irrigated only). This unit consists of deep, nearly level, well drained soils that have a surface layer of loam or silt loam and a subsoil of clay loam or silty clay.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Subclass IIe soils are on uplands and are subject to moderate erosion if they are not protected.

Unit IIe-1 (dryland and irrigated). This unit consists of deep, nearly level and gently sloping, well drained soils that have a surface layer of fine sandy loam and a subsoil of clay loam or sandy clay loam.

Unit IIe-2 (dryland and irrigated). This unit consists of deep, gently sloping, well drained soils that have a surface layer and subsoil of fine sandy loam.

Subclass IIw soils are on flood plains and uplands that have a seasonal water table and moderate limitations because of excess water.

Unit IIw-1 (dryland and irrigated). This unit consists of deep, nearly level, somewhat poorly drained soils that have a surface layer of fine sandy loam and a subsoil of sandy clay.

Subclass IIs soils are on uplands that have moderate root zone limitations because the subsoil is very slowly permeable.

Unit IIs-1 (dryland and irrigated). This unit consists of deep, nearly level, moderately well drained soils that have a surface layer of loam and a subsoil of clay.

Subclass IIc soils are on uplands where climate is the major limitation of use.

Unit IIc-1 (dryland only). This unit consists of deep, nearly level, well drained soils that have a surface layer of loam or silt loam and a subsoil of clay loam or silty clay.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Subclass IIIe soils are on uplands where the hazard of erosion is severe if the soils are cultivated and are not protected by plant cover.

Unit IIIe-1 (dryland and irrigated). This unit consists mainly of deep, undulating to rolling, well drained soils that have a sandy surface layer and subsoil. Also in this subclass are some low areas of deep, nearly level, somewhat poorly drained soils.

Unit IIIe-1 (irrigated only). This unit con-

sists of deep, gently rolling to rolling, well drained soils that have a sandy surface layer and subsoil.

Unit IIIe-2 (dryland and irrigated). This unit consists of deep, gently sloping, well drained, calcareous soils that have a surface layer of loam and a loam transitional layer over hard, calcareous, loamy underlying material.

Unit IIIe-3 (dryland only). This unit consists of deep, gently sloping, somewhat excessively drained soils that have a surface layer of sandy loam and a subsoil underlain by sand and gravel.

Subclass IIIw soils are on flood plains that have severe limitations caused by excess water.

Unit IIIw-1 (dryland and irrigated). This unit consists of deep, nearly level, somewhat poorly drained soils that have a surface layer of fine sandy loam, a transitional layer of fine sandy loam, and sandy underlying material.

Subclass IIIw soils are on flood plains that have severe limitations caused by excess water.

Unit IIIw-1 (dryland and irrigated). This unit consists of deep, nearly level, somewhat poorly drained soils that have a surface layer of fine sandy loam, a transitional layer of fine sandy loam, and sandy underlying material.

lass IV soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe soils are on uplands where the hazard of erosion is very severe if the soils are cultivated and not protected by plant cover.

Unit IVe-1 (dryland only). This unit consists of deep, gently rolling to rolling, well drained soils that have a sandy surface layer and subsoil and sandy underlying material.

Subclass IVs soils are on flood plains, stream terraces, or uplands that have very severe limitations for cultivated crops because of salinity, alkalinity, or slow available water capacity.

Unit IVs-1 (dryland and irrigated). This unit consists of deep, nearly level, somewhat poorly drained soils that have a surface layer of fine sandy loam, loam, or clay loam and a subsoil of sandy clay loam or clay loam. Saline soils are also in this unit.

Unit IVs-2 (dryland or irrigated). This unit consists of deep, nearly level, somewhat poorly drained soils that have a surface layer of fine sandy loam and a subsoil of sandy clay. Also in this unit are soils having layers of sandy clay, clay loam, or clay high in content of sodium.

Class V soils are subject to little or no erosion, but they have other characteristics that limit their use largely to pasture, range, woodland, or wildlife habitat.

Subclass Vw soils are on flood plains that have severe limitations as a result of excess water.

Unit Vw-1 (dryland only). This unit consists of deep, nearly level, poorly drained soils that have a surface layer and subsoil of fine sandy loam and sandy underlying material.

Unit Vw-2 (dryland only). This unit consists of deep, nearly level to gently rolling, wet soils that have a surface layer of loamy fine sand underlain by fine sand or loamy fine sand. Also in this unit are wet soils that have a surface layer and subsoil of fine sandy loam.

Unit Vw-3 (dryland only). This unit consists of deep, nearly level, wet soils that have a surface layer and subsoil of calcareous silty clay loam and have loamy and sandy underlying material.

Class VI soils have severe limitations that make them unsuitable for cultivated crops and restrict their use largely to pasture or range, woodland, or wildlife habitat.

Subclass VIe soils are severely limited mainly by the hazard of erosion if protective cover is not maintained.

Unit VIe-1 (dryland only). This unit consists of deep, gently rolling to rolling, well drained and excessively drained soils that have a surface layer of fine sand and a subsoil of loamy fine sand and fine sand.

Unit VIe-2 (dryland only). This unit consists of deep, nearly level and rolling, somewhat poorly drained and excessively drained soils that have a surface layer of loamy fine sand underlain by fine sand.

Subclass VIw soils are severely limited by frequent flooding and excessive water and are generally unsuitable for cultivated crops.

Unit VIw-1 (dryland only). This unit consists of deep, gently rolling to rolling, frequently flooded, poorly drained soils that have stratified sandy and loamy underlying material.

Subclass VIs soils are on flood plains that have severe limitations because of excess water and excess quantities of saline and alkaline salts.

Unit VIs-1 (dryland only). Deep, nearly level, somewhat poorly drained saline soils that have a surface layer of sandy loam, clay loam, or loam and a subsoil of clay loam or sandy clay loam containing nests of salts. The underlying material is loamy.

Class VII soils have very severe limitations that

make them unsuitable for cultivated crops and that restrict their use largely to range, woodland, or wildlife habitat.

Subclass VIIe soils are very severely limited by hazard of erosion and by a low available water capacity and low natural fertility.

Unit VIIe-1 (dryland only). Deep, hilly, excessively drained soils that are fine sand throughout.

Yields per acre

The average yields per acre that can be expected of the principal crops under optimum management are shown in table 2. In any given year yields may be higher or lower than those indicated in table 2 because of seasonal variations in rainfall and other climatic factors. Absence of a yield estimate indicates that the crop is not suited to or not commonly grown in the soil or that irrigation of a given crop is not commonly practiced on the soil.

The predicted yields are based mainly on the experience and records of farmers, conservationists, and Cooperative Extension Service agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The latest soil and crop management practices used by many farmers in the county are assumed in predicting the yields. Hay and pasture yields are predicted for varieties of grasses and legumes suited to the soil. A few farmers may be using more advanced practices and obtaining average yields higher than those shown in table 2.

TABLE 2.—*Yields per acre of crops and pasture*

[All yields were estimated for a high level of management in 1974. Absence of a yield figure indicates the crop is seldom grown or is not suited. Yields in columns N are for nonirrigated soils, those in columns I are for irrigated soils]

Soil name and map symbol	Winter wheat		Corn		Grain sorghum		Alfalfa hay		Tame pasture	
	N	I	N	I	N	I	N	I	N	I
	Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Ton*	*Ton*	*AUM*[1]	*AUM*[1]
Albion: An	17	30			26			2.0		
Attica: At	29	45		130	46	105	3.0	6.5	5.0	
Blanket: Ba	35	55		120	57	100	3.5	6.5	7.0	
Carwile: Ca, [2]Cw	22	45		130	32	105	3.5	6.5	6.0	
Clark: Cx	24	35		110	38	90	2.5	6.0		
Dillwyn:										
[2]Dp										
[2]Dt										
Farnum:										
Fa	32	50		140	52	115	3.0	6.5	5.0	
Fr	32	53		135	50	110	3.0	6.5	5.0	
Kingman: Kg										
Naron: Na	32	50		140	54	115	3.0	6.5	6.0	
Natrustolls: Nu										
Plevna: [2]Pa, [2]Pc										
Pratt:										
Ph	20	30		115	39	85	2.0	5.5		
Po	24	35		125	44	90	2.5	5.5		
[2]Pr	26	40		130	40	100	3.0	6.0		
[2]Pt										
Tabler: Ta	28	40		110	40	90		5.5		
Tivoli: Tv										
Waldeck: Wa	27	35		120	45	100	3.5	5.5	7.0	
Zenda: [2]Za	17	32		90		75		5.0		

[1]Animal-unit-months refers to the number of months during a normal growing season that 1 acre will provide grazing for one animal unit without injury to the sod. One animal unit is defined as one cow, horse, or steer; five hogs; or seven sheep.

[2]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

The predicted yields reflect the relative productive capacity of the soils for each of the principal crops. Yields are likely to increase in the future as new production technology is developed. The relative productivity of a given soil compared to other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but because their acreage is small, predicted yields for these crops are not included. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the productivity and concerns of management of the soils for these crops.

Use of Soils for Range[4]

Range is land on which the natural or climax vegetation is composed principally of native grasses, grasslike plants, forbs, and shrubs which are valuable for grazing by livestock. Range management is the management of this land to produce forage for livestock, provide habitat for wildlife, reduce sedimentation, and increase recreation and aesthetic values.

In Stafford County, income from livestock and livestock products account for about 38 percent of the total agricultural income (*8, 9*). The number of beef cows that have calved in the county ranged from 18,000 to 20,000 in the three years 1971, 1972, and 1973.

Most production of livestock forage is from rangeland. Supplemental feed is obtained from cultivated crops and their byproducts. About 19 percent of the total land area in the county, or about 96,000 acres, is range.

Range in Stafford County varies considerably in the kinds and amounts of native plants produced. Range managers or operators need to know the capabilities of different kinds of range before they can manage it properly.

Range sites and range conditions

Because of the many differences in the soils in Stafford County, there are several different kinds of range. These different kinds of range are called "range sites."

As the grasslands developed, a mixture of plants best adapted to each range site developed. This mixture of plants is called the natural or climax plant community for the site. The climax plant community for a given site varies slightly from year to year, although the kinds and proportion of plants remain about the same if undisturbed.

The original mixture of plants fitted the soil and climate of the range site so perfectly that other kinds of plants did not volunteer unless an area was disturbed. So consistent is the relation between plants, climate, and soils that the climax plant community can be accurately predicted even on severely disturbed sites if the soil is identified.

Range conservationists and soil scientists, working together, group soils that can potentially support the same climax plant communities into range sites.

Repeated overuse by grazing animals, excessive burning, and plowing result in changes in the kinds, proportions, or amounts of climax plants. Depending on the kind and degree of disturbance, some kinds of plants increase while others decrease. If the disturbance is too severe, plants that are not a natural part of the climax plant community may invade, and some natural plants may be eliminated. Under these circumstances forage production usually decreases. Plant response to grazing depends on the kind of grazing animal, the season of use, and how closely the plant is grazed. If good management follows disturbances, however, the climax plant community is gradually reestablished unless soils have been severely eroded.

Range condition is an expression of how closely the present plant community compares with the climax plant community for a given range site. The more nearly the present kinds and proportionate amount of plants are like the climax plant mixture, the better the range condition.

Four range condition classes are used to indicate the degree of departure from the natural or climax plant community brought about by grazing or other uses. These classes show the present condition of the plant community or a range site in relation to the potential climax plant community.

A range site is in excellent condition if 76 to 100 percent of the present plant community is the same kind as that in the climax plant community. It is in good condition if 51 to 75 percent is the same as the climax plant community, in fair condition if 26 to 50 percent is the same, and in poor condition if less than 26 percent is the same.

The present range condition provides an index to changes that have taken place in the plant community. More important, however, range condition provides a basis for predicting the kinds and proportionate amount of changes in the present plant community that can be expected from management and treatment measures. Thus, the range condition rating indicates the nature of the present plant community. The climax cover for the range sites represents a goal towards which range management may be directed.

Knowledge of the climax plant communities of range sites and the nature of present plant communities in relation to that potential is important in planning and applying conservation practices to range. Such information is the basis for selecting management objectives, designing grazing systems, managing wildlife habitats, determining recreation potential, and rating watershed conditions.

Any objective for managing range must provide for a plant cover that will adequately protect or improve the soil and water resources and meet the needs of the operator. This usually involves maintaining or increasing desirable plants and restoring the plant community to near climax conditions where it has been degraded. Sometimes, however, a plant community somewhat below climax conditions will better fit spe-

[4]By ARNOLD G. MENDENHALL, range conservationist, Soil Conservation Service.

cific grazing needs, provide better wildlife habitat, or furnish other benefits and still protect the soil and water resources.

Descriptions of range sites

The range sites of Stafford County are described in the paragraphs that follow. An approximate species composition of the dominant plants of the climax plant community is listed for each site. Plant species most likely to invade are also listed. In addition, an estimate of the potential annual production on an air dry weight basis of the vegetation is indicated for each site. The soils in each range site may be determined by referring to the "Guide to Mapping Units" at the back of this soil survey.

CHOPPY SANDS RANGE SITE

Tivoli fine sand, hilly, is the only soil in this range site. The surface layer is loose, and blowouts are in some areas. This soil is rapidly permeable, excessively drained, and has low available water capacity. Hilly areas of Tivoli fine sand are often bounded by hummocky areas of Dillwyn-Tivoli loamy fine sands.

The climax plant community on this range site is predominantly a mixture of warm season grasses and forbs. Approximate species composition, by weight, of the dominant plants in the climax plant community is as follows: sand bluestem, 25 percent; little bluestem, 20 percent; sand lovegrass, 5 percent; big sandreed, 10 percent; switchgrass, 10 percent; indiangrass, 10 percent; sand dropseed, 5 percent; sand paspalum, 5 percent; Texas bluegrass, 5 percent; and Virginia tephrosia 5 percent.

If the climax plant community deteriorates as a result of continuous overgrazing by livestock, such plants as sand bluestem, little bluestem, sand lovegrass, Virginia tephrosia, big sandreed, and switchgrass decrease in abundance and forage production. As these plants decrease in abundance, such less productive plants as sand dropseed, sand paspalum, blue grama, sand plum, and western ragweed increase. If the plant community continues to deteriorate as a result of long periods of overgrazing, plants such as annual eriogonum, camphorweed, annual broomweed, sandbur, annual threeawn, witchgrass, windmillgrass, and other annuals invade the plant community.

In the absence of proper brush management practices, this site becomes heavily invaded with such woody plants as sand plum, skunkbush, cottonwood, and willow.

When this site is in excellent condition, the average annual yield of air dry herbage is approximately 1,800 pounds per acre, but it may vary from about 2,500 pounds in favorable years to about 1,000 pounds in unfavorable years.

CLAY UPLAND RANGE SITE

Tabler loam is the only soil in this range site. It is a deep, nearly level, moderately well drained, clayey soil on uplands. Permeability is very slow, and runoff is slow. This soil is droughty during periods of low rainfall.

The climax plant community on this range site is predominantly a mixture of warm season grasses and forbs. Approximate species composition, by weight, of the dominant plants in the climax plant community is as follows: big bluestem, 20 percent; western wheatgrass, 20 percent; side-oats grama, 15 percent; little bluestem, 10 percent; switchgrass, 5 percent; tall dropseed, 5 percent; blue grama, 10 percent; buffalograss, 5 percent; slimflower scurfpea, 5 percent; and dotted gayfeather, 5 percent.

If the climax community deteriorates as a result of continuous overgrazing by livestock, such plants as big bluestem, western wheatgrass, side-oats grama, little bluestem, and switchgrass decrease in abundance and forage production. As these plants decrease in abundance, such less productive plants as tall dropseed, blue grama, buffalograss, western ragweed, sagewort, and sand dropseed increase. If the plant community continues to deteriorate as a result of long periods of overgrazing, such plants as silver bluestem, three-awns, annual broomweed, snow-on-the-mountain, tumblegrass, and other annuals invade the plant community.

When this range site is in excellent condition, the average annual yield of air dry herbage is approximately 3,000 pounds per acre, but it may vary from about 5,000 pounds in favorable years to about 2,000 pounds in unfavorable years.

LIMY UPLAND RANGE SITE

Clark loam, 1 to 3 percent slopes, is the only soil in this range site. It is a deep, well drained, calcareous, loamy soil on uplands. Permeability is moderate, runoff is medium, and available water capacity is high.

The climax plant community on this range site is predominantly a mixture of warm season grasses and forbs. Approximate species composition, by weight, of the dominant plants in the climax plant community is as follows: big bluestem, 25 percent; little bluestem, 20 percent; side-oats grama, 20 percent; indiangrass, 5 percent; switchgrass, 5 percent; blue and hairy grama, 5 percent; leadplant, 5 percent; catclaw sensitivebrier, 5 percent; blacksamson, 5 percent; and western wheatgrass, 5 percent.

If the climax plant community deteriorates as a result of continuous overgrazing by livestock, such plants as big bluestem, little bluestem, indiangrass, switchgrass, leadplant, catclaw sensitivebrier, and blacksamson decrease in abundance and forage production. As these plants decrease in abundance, such less productive plants as western wheatgrass, bluegrama, side-oats grama, hairy grama, buffalograss, tall dropseed, dotted gayfeather and broom snakeweed increase. If the plant community continues to deteriorate as a result of long periods of overgrazing, such plants as silver bluestem, annual broomweed, threeawns, and other annuals invade the plant community.

When this site is in excellent condition, the average annual yield of air dry herbage is approximately 3,000 pounds per acre, but it may vary from about 4,500 pounds in favorable years to about 2,000 pounds in unfavorable years.

LOAMY UPLAND RANGE SITE

This range site consists of nearly level, deep, well drained soils of the Blanket and Farnum series. Permeability is moderately slow, and the available water capacity is high.

The climax plant community on this range site is predominantly a mixture of warm season grasses and forbs. Approximate species composition, by weight, of the dominant plants in the climax plant community is as follows: big bluestem, 35 percent; side-oats grama, 20 percent; blue grama, 10 percent; little bluestem, 5 percent; switchgrass, 5 percent; indiangrass, 5 percent; western wheatgrass, 5 percent; tall dropseed, 5 percent; Illinois bundleflower, 5 percent; and wild alfalfa, 5 percent.

If the climax plant community deteriorates as a result of continuous overgrazing by livestock, such plants as big bluestem, little bluestem, switchgrass, indiangrass, and Illinois bundleflower decrease in abundance and forage production. As these plants decrease in abundance, such less productive plants as western wheatgrass, side-oats grama, tall dropseed, blue grama, buffalograss, and western ragweed increase. If the plant community continues to deteriorate as a result of long periods of overgrazing, such plants as annual broomweed, three-awn, silver bluestem, annual brome, and other annuals invade the plant community.

When this site is in excellent condition, the average annual yield of air dry herbage is approximately 3,500 pounds per acre, but it may vary from about 5,000 pounds in favorable years to about 2,000 pounds in unfavorable years.

SALINE SUBIRRIGATED RANGE SITE

Natrustolls are the only soils in this range site. They are deep, nearly level, somewhat poorly drained, saline and alkali soils on low terraces bordering flood plains. A fluctuating water table is at a depth of 2 to 6 feet, but it rises to near the surface during wet seasons.

The climax plant community on this range site is predominantly a mixture of warm season grasses and forbs. Approximate species composition, by weight, of the dominant plants in the climax plant community is as follows: alkali sacaton, 25 percent; alkali cordgrass, 20 percent; switchgrass, 20 percent; indiangrass, 5 percent; knotroot bristlegrass, 5 percent; inland saltgrass, 10 percent; Canada wildrye, 3 percent; western wheatgrass, 5 percent; Illinois bundleflower, 3 percent; and Maximilian sunflower, 4 percent.

If the climax plant community deteriorates as a result of continuous overgrazing by livestock, all of the plants given in the previous paragraph except inland saltgrass decrease in abundance and forage production. As these plants decrease in abundance, such less productive plants as inland saltgrass, tall dropseed, sedges, blue grama, and western ragweed increase. If the plant community continues to deteriorate as a result of long periods of overgrazing, such plants as windmillgrass, tumblegrass, annual brome, and other annuals invade the plant community. Tamarisk and Russian-olive are serious woody invaders on this site regardless of the condition of the plant community.

When this site is in excellent condition, the average annual yield of air dry herbage is approximately 6,500 pounds per acre, but it may vary from about 8,500 pounds in favorable years to about 5,500 pounds in unfavorable years.

SANDS RANGE SITE

This range site consists of deep, undulating to rolling soils of the Pratt and Tivoli series. The surface layer is loamy fine sand, and the subsoil or underlying material is loamy fine sand or fine sand. These soils absorb moisture rapidly, but they have a low available water capacity (fig. 11).

The climax plant community on this range site is predominantly warm season grasses and forbs. Approximate species composition, by weight, of the dominant plants in the climax plant community is as follows: sand bluestem, 35 percent; little bluestem, 15 percent; switchgrass, 20 percent; indiangrass, 5 percent; sand lovegrass, 5 percent; big sandreed, 5 percent; sand dropseed, 5 percent; Scribner panicum, 5 percent; leadplant, 3 percent; and Virginia tephrosia, 2 percent.

If the climax plant community deteriorates as a result of continuous overgrazing by livestock, such plants as sand bluestem, little bluestem, switchgrass, indiangrass, sand lovegrass, big sandreed, leadplant, and Virginia tephrosia decrease in abundance and forage production. When these plants decrease in abundance, such less productive plants as sand dropseed, sand paspalum, blue grama, sand plum, and western ragweed increase. If the plant community continues to deteriorate as a result of long periods of overgrazing, such plants as camphorweed, sandbur, wild buckwheat, annual sunflower, and other annuals invade the plant community.

Such woody plants as sand plum and skunkbush are common but in small amounts in the climax plant community. In the absence of proper brush management, this site is increasingly invaded with these plants.

When this site is in excellent condition, the average annual yield of air dry herbage is approximately 3,000 pounds per acre, but it may vary from about 4,500 pounds in favorable years to about 2,000 pounds in unfavorable years.

SANDY RANGE SITE

This range site consists of deep, nearly level and gently sloping soils of the Albion, Attica, Carwile, Farnum, and Naron series. The surface layer is sandy loam or fine sandy loam and the subsoil is sandy loam, sandy clay loam, clay loam, or sandy clay. Permeability is slow, moderately slow, moderate, or moderately rapid. Available water capacity ranges from low to high. Moisture intake is moderate to rapid, and runoff is slow.

The climax plant community of this range site is predominantly a mixture of warm season grasses and forbs. Approximate species composition, by weight, of

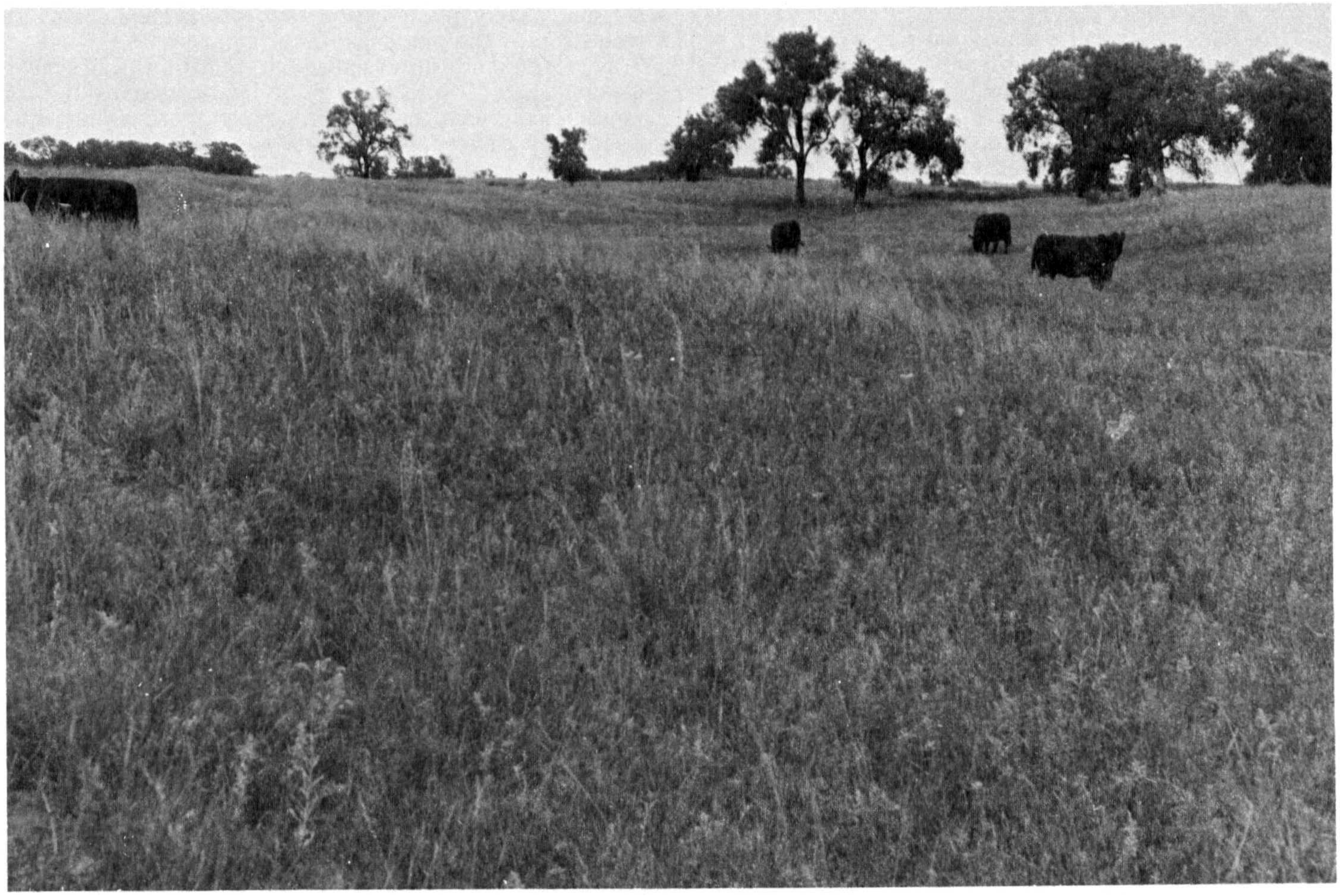

Figure 11.—**Sands range site in fair condition where, because of overgrazing, weeds are invading the plant community. Cottonwood trees are in low areas of this range site.**

the dominant plants in the climax plant community is as follows: little bluestem, 30 percent; sand bluestem, 30 percent; switchgrass, 10 percent; indiangrass, 5 percent; sand lovegrass, 5 percent; sand dropseed, 5 percent; Scribner panicum, 5 percent; leadplant, 3 percent; catclaw sensitivebrier, 2 percent; and side-oats grama, 5 percent.

If the climax plant community deteriorates as a result of continuous overgrazing by livestock, such plants as little bluestem, sand bluestem, indiangrass, switchgrass, sand lovegrass, leadplant, and catclaw sensitivebrier decrease in abundance and forage production. As these plants decrease in abundance, such less productive plants as side-oats grama, sand dropseed, blue grama, sand paspalum, and western ragweed increase. If the plant community continues to deteriorate as a result of long periods of overgrazing, such plants as silver bluestem, wild buckwheat, camphorweed, annual broomweed, and other annuals invade the plant community.

Such woody plants as sand plum and skunkbush are common in small amounts in the climax plant community, but in the absence of proper brush management practices, this site is increasingly invaded with these plants.

When this site is in excellent condition, the average annual yield of air dry herbage is approximately 2,500 pounds per acre, but it may vary from about 4,000 pounds in favorable years to about 1,800 pounds in unfavorable years.

SUBIRRIGATED RANGE SITE

This range site consists of nearly level to gently rolling, somewhat poorly drained and poorly drained, sandy and loamy soils of the Dillwyn, Plevna, Kingman, Waldeck, and Zenda series. The surface layer is loamy fine sand, fine sandy loam, loam, or silty clay loam. Underlying layers are sandy or loamy. A fluctuating water table is at a depth of 1 to 6 feet. This water table significantly affects the kinds and amounts of potential vegetation.

The climax plant community on this range site is predominantly a mixture of warm season grasses and forbs. Approximate species composition, by weight, of the dominant plants in the climax plant community is as follows: eastern gamagrass, 25 percent; indiangrass, 20 percent; big bluestem, 15 percent; prairie cordgrass, 20 percent; switchgrass, 5 percent; little bluestem, 5 percent; side-oats grama, 2 percent; tall goldenrod, 2 percent; Maximilian sunflower, 4 percent;

and Illinois bundleflower, 2 percent.

If the climax plant community deteriorates as a result of continuous overgrazing by livestock, such plants as eastern gamagrass, indiangrass, big bluestem, switchgrass, prairie cordgrass, Maximilian sunflower, and Illinois bundleflower decrease in abundance and forage production. As these plants decrease in abundance, such less productive plants as little bluestem, side-oats grama, and western ragweed increase. If the plant community continues to deteriorate as a result of long periods of overgrazing, plants such as silver bluestem, windmillgrass, tumblegrass, annual broomweed, and other annuals invade the plant community.

In the absence of fire and proper brush management practices, this site becomes heavily invaded with such woody plants as willow, Russian-olive, dogwood, and cottonwood.

When this site is in excellent condition, the average annual yield of air dry herbage is approximately 8,000 pounds per acre, but it may vary from about 9,000 pounds in favorable years to about 7,000 pounds in unfavorable years.

Use of Soils for Windbreaks

Windbreaks are established to protect livestock, buildings, and yards against winds and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of both broad leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the width of the interval depending on the susceptibility of the soil to erosion. The windbreaks protect cropland and crops from wind and hold snow on the fields. They also provide food and cover for wildlife (fig. 12).

Figure 12.—**Eight row windbreak on Pratt loamy fine sand, undulating. Eastern redcedar and Siberian Elm dominate the southern part of this windbreak.**

Environmental plantings help to beautify and screen homes and other buildings and to abate noise around them. The plants, mostly evergreen shrubs and trees, are closely spaced. Healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition insures a high degree of plant survival.

Planting and care of windbreaks

Areas to be planted to windbreaks need to be carefully planned, and the seedbed needs to be prepared before the trees are planted. Species of trees and shrubs best adapted to the soils of the area should be selected. Loss of trees in windbreak plantings is generally the result of a lack of conservation practices that conserve moisture or the result of poor seedbed preparation. It is essential that a firm, weed free seedbed be prepared before the trees are planted. Most areas to be planted to windbreaks in Stafford County can be prepared the same way areas are prepared for cultivated field crops.

Seedings should be planted early in spring, and they should be protected so they will not dry out during planting. The soil should be tamped firmly around the roots of seedlings as they are planted.

Rainfall in Stafford County is likely to be limited and irregular in occurence. Young trees require considerable care if they are to survive and grow well in a prairie climate. The windbreak should be cultivated as often as necessary to control weeds and thus reduce this competition for moisture.

Windbreaks need to be protected against damage by livestock. Protection from fire is important and can be achieved by continuous cultivation for weed control on the isolation strip surrounding the windbreak. Sometimes rabbits and mice chew the bark and girdle young trees in a windbreak, and a recommended repellant should be used to control rodents.

Stafford County is in a natural grassland area. Survival and growth of trees in this area are greatly influenced by the nature of the soil and by the soil, air and moisture relationship. Trees normally grow best on sandy loam soils. Only fair growth can be expected on clayey soils because soil moisture is absorbed and released slowly by the clay. This is especially true of upland clayey soils, which tend to be droughty. Trees grow poorly in very sandy soils because these soils do not store enough water and plant nutrients.

Dillwyn, Plevna, Kingman, Tivoli soils, and Natrustolls are too wet, too sandy, or too saline for the routine cultivation necessary to establish and maintain a windbreak without special management practices.

Table 3 shows the height that locally adapted trees and shrubs are expected to reach on various kinds of soils in 20 years. The estimates in table 3 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks. Additional information about planning windbreaks and the planting and care of trees can be obtained from the local office of the Soil Conservation Service, from the Cooperative Extension Service, or from the local nurserymen.

Use of Soils for Wildlife[5]

The soils in Stafford County have a high potential for the development of wildlife habitat. Access roads are good throughout the County except in hilly areas and in some areas along Rattlesnake Creek and the North Fork of the Ninescah River.

Rattlesnake Creek, the North Fork of the Ninnescah River, and parts of Wild Horse Creek provide good fishing for bass, bluegill, channel catfish, and bullheads. There are few farm ponds, but numerous natural pools are fished along these major streams.

The hunting season for pheasant, quail, ducks, and geese draws many hunters to Stafford County. Pheasant and quail are well adapted to cultivated fields, shelter-belts, pastures, and meadows. Cottontail rabbits are common in woodlands and brush areas along streams.

The Quivira National Wildlife Refuge has an area of 21,820 acres of salt marsh and native vegetation. It is in eastern Stafford County. Migrating waterfowl are hunted on designated areas during open hunting seasons. Whooping cranes sometimes use the Refuge during their migration. Bald eagles and golden eagles use the Refuge in winter. A large variety of waterfowl and shore birds may be observed throughout the different seasons of the year. Upland game birds and animals may also be hunted during open seasons.

Raccoon, beaver, skunk, opossum, and muskrat are furbearers commonly associated with wet and wooded areas of the county. Such songbirds as meadowlarks, robins, mockingbirds, doves, and cardinals are common. A few brown thrashers have been observed in shelterbelts. Insect eating birds, such as flycatchers, also are common. Numerous crows return each year to nesting areas in the trees of shelterbelts and in trees along Rattlesnake Creek, Wild Horse Creek, and the North Fork of the Ninnescah River. Hawks and other birds of prey may be seen as they hunt for food on the land below.

Soils directly affect the kind and amount of vegetation that are available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populates an area depends largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or is inaccessible, wildlife will either be scarce or will not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

In table 4 the soils in Stafford County are rated according to their potential to support the main kinds

[5]ROBERT J. HIGGINS, biologist, Soil Conservation Service, assisted in the preparation of this section

of wildlife habitat in the county. This information can be used to plan the use of parks, wildlife refuges, nature study areas, and other developments for wildlife; select soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; determine the intensity of management needed for each element of the habitat; and determine areas that are suitable for acquisition to manage as wildlife habitat.

The potential of the soil is rated good, fair, poor, or very poor in table 4. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, if the rating is poor, but management is difficult and requires intensive effort. A rating of *very poor* means that limitations for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is im-

TABLE 3.—*Windbreaks and environmental plantings*

[Absence of an entry means the species is not suited to this soil]

Soil name and map symbol	Expected heights in feet of specified trees at 20 years of age							
	Eastern cottonwood	Eastern redcedar	Hackberry	Honey-locust	Ponderosa pine	Russian-olive	Siberian elm	Osage orange
Albion: An		16			18		20	
Attica: At	32	22	18	19	25		35	23
Blanket: Ba	35	25	26	22	24	16	40	26
Carwile: Ca, [1]Cw	45	25	22	20			25	20
Clark: Cx	20	24	27	30	25	19	40	22
Dillwyn:								
[1]Dp:								
[2]Dillwyn part	45	25	28	28	30	15	30	24
[2]Plevna part	47	25	28	30	25	15	35	28
[1]Dt:								
[2]Dillwyn part	45	25	28	28	30	15	30	24
[2]Tivoli part	25	15		18		15	25	15
Farnum: Fa, Fr	35	25	25	24	20	17	37	25
Kingman: [2]Kg	42	23	20	25		15	25	25
Naron: Na	37	24	27	35	25	17	44	23
Natrustolls: Nu	18	15				15		15
Plevna: [1]Pa, [2]Pc	47	25	28	30	25	15	30	28
Pratt:								
Ph, Po	35	18	20	25	20	15	30	15
[1]Pr:								
Pratt part	35	18	20	25	20	15	30	15
Carwile part	45	25	22	20			25	20
[1]Pt:								
Pratt part	35	18	20	25	20	15	30	15
[2]Tivoli part	20	15		18		15	25	15
Tabler: Ta	40	20	22	20			35	24
Tivoli: Tv	20	15		18		15	25	15
Waldeck: Wa	50	30	35		30	18	50	28
Zenda: [1]Za	45	27	27			17	45	

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

[2]These soils are poorly suited to routine cultivation and require special management practices to establish and maintain a windbreak.

TABLE 4.—*Wildlife habitat potentials*

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for—			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hard-wood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Open-land wildlife	Rangeland wildlife	Wetland wildlife	Woodland wildlife
Albion: An	Fair	Good	Fair	Poor	Poor	Fair	Very poor	Very poor	Fair	Fair	Very poor	Fair.
Attica: At	Good	Good	Good	Good	Good	Fair	Poor	Very poor	Good	Fair	Very poor	Good.
Blanket: Ba	Good	Good	Fair	Good	Good	Good	Poor	Very poor	Good	Fair	Very poor	Good.
Carwile: Ca, [1]Cw	Fair	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair	Good.
Clark: Cx	Fair	Good	Fair	Good	Good	Poor	Poor	Very poor	Fair	Poor	Very poor	Good.
Dillwyn:												
[1]Dp:												
Dillwyn part	Poor	Fair	Good	Good	Good	Fair	Fair	Good	Fair	Fair	Fair	Good.
Plevna part	Poor	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good	Fair.
[1]Dt:												
Dillwyn part	Poor	Fair	Good	Good	Good	Fair	Fair	Good	Fair	Fair	Fair	Good.
Tivoli part	Poor	Poor	Fair	Poor	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor	Poor.
Farnum: Fa, Fr	Good	Good	Good	Good	Good	Fair	Fair	Poor	Good	Fair	Poor	Good.
Kingman: Kg	Poor	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
Naron: Na	Good	Good	Good	Good	Good	Fair	Poor	Very poor	Good	Fair	Very poor	Good.
Natrustolls: Nu	Poor	Poor	Very poor	Poor	Very poor	Poor	Fair	Fair	Poor	Very poor	Fair	Very poor.
Plevna: [1]Pa, [1]Pc	Poor	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good	Fair.
Pratt:												
Ph, Po	Fair	Good	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor	Fair.
[1]Pr:												
Pratt part	Fair	Good	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor	Fair.
Carwile part	Fair	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair	Good.
[1]Pt:												
Pratt part	Fair	Good	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor	Fair.
Tivoli part	Poor	Poor	Fair	Poor	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor	Poor.
Tabler: Ta	Good	Good	Fair	Good	Good	Fair	Poor	Poor	Good	Fair	Poor	Good.
Tivoli: Tv	Poor	Poor	Fair	Poor	Poor	Poor	Very poor	Very poor	Poor	Poor	Very poor	Poor.
Waldeck: Wa	Fair	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair	Good.
Zenda: [1]Za	Fair	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair	Good.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

practical or even impossible to create, improve, or maintain on soils that have such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed producing annuals used by wildlife. Examples are corn, sorghum, wheat, oats, barley, millet and soybeans. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, bluegrass, bromegrass, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, indiangrass, switchgrass, lovegrass, wheatgrass, grama, goldenrod, pokeweed, native lespedeza, partridgepea, clovers, and sunflowers. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Examples of native plants are oak, sycamore, elm, cottonwood, hackberry, hawthorn, dogwood, persimmon, hickory, greenbrier, black walnut, grape, and briers. Examples of fruit producing shrubs that are commercially available and suitable for planting in soils rated good are Russian-olive, autumn-olive, bush honeysuckle, and crabapple. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are trees, shrubs, or ground cover that furnish habitat for wildlife or supply food in the form of browse, seeds, or fruitlike cones. Examples are pine, spruce, yew, cedar, and juniper. Major soil properties that affect the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Shrubs are bushy woody plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are sumac, buckbrush, blackberry, and plum. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow in moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, rushes, sedges, cattails, saltgrass, cordgrass, buttonbush, and indigobush amorpha. Major soil properties that affect wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of surface water that have an average depth of less than 5 feet and are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of habitat are briefly described in the following paragraphs.

Openland habitat consists of croplands, pastures, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, morning dove, field sparrow, crow, cottontail rabbit, skunk, and woodchuck.

Rangeland habitat consists of wild herbaceous plants and shrubs on range. Examples of wildlife attracted to this habitat are muledeer, prairie dog, jackrabbit, coyote, badger, killdeer, meadowlark, and lark bunting.

The soils of Stafford County provide suitable habitat for many kinds of animals and birds. The most important game birds are ducks, geese, ringneck pheasant, and bobwhite quail. Alluvial soils along Rattlesnake Creek, the North Fork of the Ninnescah River, Wild Horse Creek, and Peace Creek produce habitat for deer, raccoon, squirrel, muskrat, opossum, and songbirds.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are ducks, geese, herons, shore birds, red-wing blackbirds, kingfishers, muskrat, mink, and beaver.

Woodland habitat consists of hardwoods, conifers, or a mixture of both, and associated grasses, legumes, shrubs, vines, and wild herbaceous plants. Examples of wildlife attracted to this habitat are wild turkey, cardinals, thrushes, vireos, woodpeckers, tree squirrels, gray fox, raccoon, opossum, and white-tailed deer.

Development of a habitat for wildlife requires plant cover that the soils can produce in the proper locations. Onsite technical assistance in planning and determining suitable plant species for wildlife areas can be obtained from the Stafford County Conservation District Office, Soil Conservation Service; the Bureau of Sports Fisheries and Wildlife; the Kansas Forestry, Fish, and Game Commission; and the Cooperative Extension Service.

Use of Soils for Recreation[6]

Stafford County is served by two major U.S. highways: U.S. Highway 281 and U.S. Highway 50. U.S. Highway 281 crosses the county from north to south, and U.S. Highway 50 crosses it from east to west. Most all of the areas of the county are accessible by good roads except for some of the sandhills and areas along Rattlesnake Creek and the North Fork of the Ninnescah River.

Hunting is the major attraction at Quivira National Wildlife Refuge. Ducks, geese, pheasants, bobwhite quail, doves, snipes, squirrels, rabbits, and crows may be hunted in accordance with regulations when seasons are open. No overnight camping or fires of any type are permitted within the refuge. A large area around Quivira National Wildlife Refuge is leased each year to persons and clubs for waterfowl and upland game bird hunting. Other areas near Rattlesnake Creek, the North Fork of the Ninnescah River, and areas near Seward, Kansas, are also leased for hunting. Many smaller water areas throughout the county are leased for hunting, fishing, and camping. Private clubs provide facilities for trap-shooting and rifle and pistol shooting.

A well kept nine hole golf course southwest of St. John has a clubhouse and has golf cart storage facilities.

Flowing artesian wells near Big Marsh at the western edge of the Quivira National Wildlife Refuge attract many people each year.

Good water supplies and good access roads throughout Stafford County provide excellent opportunities, both public and private, for further recreational development.

The soils of Stafford County are rated in table 5 according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area, and its scenic quality. Also important, but not considered for the ratings, are the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degrees, for recreational use by the duration of flooding and the season of occurrence. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreational facilities.

In table 5 the limitations of soils are rated as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and are easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 5 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields given in table 6 and interpretations for dwellings without basements and for local roads and streets given in table 7.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Steep slopes and stones or boulders on the surface can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for this use are firm when wet but not dusty when dry, are not subject to flooding during the period of use, are level or nearly level, and do not have stones or boulders on the surface that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are nearly level and not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth to bedrock should be sufficient to allow for necessary grading.

The design and layout of paths and trails for walking, horseback riding, and bicycling should require little or no cutting and filling. The best soils for this use are not wet, are firm after rainfall, are not dusty when dry, and are not subject to flooding more than once during the period of use. Slopes should be moderate or less, and there should be few or no stones or boulders on the surface.

Engineering Uses of the Soils[7]

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in table 6, 7, 8, and 9 are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

[6]LARRY C. DOUD, conservation technician, Soil Conservation Service, assisted in the preparation of this section.

[7]CLIFTON E. DEAL, civil engineer, Soil Conservation Service, assisted in the preparation of this section.

TABLE 5.—*Recreational development*

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Albion: An	Slight	Slight	Moderate: slope	Slight.
Attica: At	Slight	Slight	Moderate: slope	Slight.
Blanket: Ba	Moderate: percs slowly	Slight	Moderate: percs slowly	Slight.
Carwile: Ca, [1]Cw	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Clark: Cx	Slight	Slight	Moderate: slope	Slight.
Dillwyn:				
[1]Dp:				
Dillwyn part	Severe: wetness	Moderate: wetness	Severe: wetness	Moderate: wetness.
Plevna part	Severe: floods, wetness	Severe: floods, wetness	Severe: floods, wetness	Severe: wetness.
[1]Dt:				
Dillwyn part	Severe: wetness	Moderate: wetness	Severe: wetness	Moderate: wetness.
Tivoli part	Severe: too sandy, dusty	Severe: too sandy, dusty	Severe: too sandy, dusty	Severe: too sandy, dusty.
Farnum: Fa, Fr	Moderate: percs slowly	Slight	Moderate: percs slowly	Slight.
Kingman: Kg	Severe: wetness, floods	Severe: wetness	Severe: wetness	Severe: wetness.
Naron: Na	Slight	Slight	Slight	Slight.
Natrustolls: Nu	Severe: wetness, floods, excess salt.	Moderate: floods, wetness, excess salt.	Moderate: percs slowly, wetness, excess salt.	Moderate: wetness, exces salt.
Plevna: [1]Pa, [1]Pc	Severe: floods, wetness	Severe: floods, wetness	Severe: floods, wetness	Severe: wetness.
Pratt:				
Ph	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
Po	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
[1]Pr:				
Pratt part	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
Carwile part	Severe: wetness, surface ponding.	Severe: wetness	Severe: wetness	Severe: wetness.
[1]Pt:				
Pratt part	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
Tivoli part	Severe: too sandy, dusty	Severe: too sandy, dusty	Severe: too sandy, dusty	Severe: too sandy, dusty.
Tabler: Ta	Severe: percs slowly	Moderate: too clayey	Severe: percs slowly	Moderate: too clayey.
Tivoli: Tv	Severe: too sandy, dusty	Severe: too sandy, dusty	Severe: too sandy, dusty	Severe: too sandy, dusty.
Waldeck: Wa	Severe: floods, wetness	Moderate: floods, wetness	Moderate: floods, wetness	Moderate: wetness.
Zenda: [1]Za	Severe: floods, wetness	Moderate: floods, wetness	Moderate: floods, wetness	Moderate: wetness.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

Among the soil properties and site conditions identified by the soil survey and used in determining the ratings in this section are grain size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within 5 or 6 feet of the surface, soil wetness characteristics, depth to a seasonal water table slope, likelihood of flooding, natural soil structure or aggregation, inplace soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

Based on the information assembled about soil properties, ranges of values may be estimated for susceptibility to erosion, permeability, corrosivity, shrink swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values may be applied to each major horizon of each soil or to the entire profile.

The foregoing factors affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering projects. The ranges of values can be used to select potential residential, commercial, industrial, and recreational areas; make preliminary estimates pertinent to construction

TABLE 6.—*Sanitary facilities*

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe" and other terms used to rate soils]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Albion: An	Slight	Severe[1]: seepage	Severe[1]: seepage	Severe[1]: seepage	Fair: thin layer.
Attica: At	Slight	Severe[1]: seepage	Severe[1]: seepage	Severe[1]: seepage	Good.
Blanket: Ba	Severe: percs slowly	Slight	Moderate: too clayey	Slight	Fair: too clayey.
Carwile: Ca, [2]Cw	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: floods, too clayey.	Severe: wetness, floods.	Poor: thin layer.
Clark: Cx	Moderate: percs slowly.	Moderate: seepage	Slight	Slight	Good.
Dillwyn:					
[2]Dp:					
Dillwyn part	Severe[1]: wetness	Severe[1]: wetness, seepage.	Severe[1]: wetness, seepage.	Severe[1]: wetness, seepage.	Fair: too sandy, wetness.
Plevna part	Severe[1]: floods, wetness.	Severe[1]: floods, wetness.	Severe[1]: floods, wetness.	Severe[1]: floods, wetness.	Poor: wetness.
[2]Dt:					
Dillwyn part	Severe[1]: wetness	Severe[1]: wetness, seepage.	Severe[1]: wetness, seepage.	Severe[1]: wetness, seepage.	Fair: too sandy, wetness.
Tivoli part	Moderate[1]: slope	Severe[1]: seepage, slope.	Severe[1]: seepage, too sandy.	Severe[1]: seepage	Poor: thin layer, too sandy.
Farnum: Fa, Fr	Severe: percs slowly	Slight	Moderate: too clayey	Slight	Fair: too clayey.
Kingman: Kg	Severe: wetness, floods, percs slowly.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Naron: Na	Slight	Moderate: seepage	Moderate: seepage	Moderate: seepage	Good.
Natrustolls: Nu	Severe: percs slowly	Severe[1]: floods, seepage.	Severe[1]: floods, seepage.	Severe: floods	Poor: thin layer.
Plevna: [2]Pa, [2]Pc	Severe[1]: floods, wetness.	Severe[1]: floods, wetness.	Severe[1]: floods, wetness.	Severe[1]: floods, wetness.	Poor: wetness.
Pratt:					
Ph, Po	Slight[1]	Severe[1]: seepage	Severe[1]: seepage	Severe[1]: seepage	Fair: too sandy.
[2]Pr:					
Pratt part	Slight[1]	Severe[1]: seepage	Severe[1]: seepage	Severe[1]: seepage	Fair: too sandy.
Carwile part	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: floods, too clayey.	Severe: wetness, floods.	Poor: thin layer.
[2]Pt:					
Pratt part	Slight[1]	Severe[1]: seepage	Severe[1]: seepage	Severe[1]: seepage	Fair: too sandy.
Tivoli part	Moderate[1]: slope	Severe[1]: seepage, slope.	Severe[1]: seepage, too sandy.	Severe[1]: seepage	Fair: too sandy.
Tabler: Ta	Severe: percs slowly, wetness.	Slight	Severe: wetness, too clayey.	Severe: wetness	Poor: hard to pack, too clayey.
Tivoli: Tv	Moderate[1]: slope	Severe[1]: seepage, slope.	Severe[1]: seepage, too sandy.	Severe[1]: seepage	Poor: too sandy.
Waldeck: Wa	Severe[1]: floods	Severe[1]: floods, seepage.	Severe[1]: floods, seepage.	Severe[1]: floods, seepage.	Good.
Zenda: [2]Za	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Fair: too clayey.

[1]Pollution may be a hazard to the water supply.
[2]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

in a particular area; evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; plan detailed onsite investigations of soils and geology; find sources of gravel, sand, clay, and topsoil; plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for

TABLE 7.—*Building site development*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Albion: An	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Attica: At	Slight	Slight	Slight	Slight	Slight.
Blanket: Ba	Moderate: too clayey	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Carwile: Ca, [1]Cw	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: low strength, shrink-swell.
Clark: Cx	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Severe: low strength.
Dillwyn:					
[1]Dp:					
Dillwyn part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness	Moderate: wetness.
Plevna part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
[1]Dt:					
Dillwyn part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness	Moderate: wetness.
Tivoli part	Severe: cutbanks cave, too sandy.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
Farnum: Fa, Fr	Moderate: too clayey	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Severe: low strength.
Kingman: Kg	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Naron: Na	Slight	Slight	Slight	Slight	Slight.
Natrustolls: Nu	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Plevna: [1]Pa, [1]Pc	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Pratt:					
Ph	Severe: too sandy, cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Po	Severe: too sandy, cutbanks cave.	Slight	Slight	Slight	Slight.
[1]Pr:					
Pratt part	Severe: too sandy, cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Carwile part	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: low strength, shrink-swell.
[1]Pt:					
Pratt part	Severe: too sandy, cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Tivoli part	Severe: cutbanks cave, too sandy.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
Tabler: Ta	Severe: too clayey	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Tivoli: Tv	Severe: cutbanks cave, too sandy.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
Waldeck: Wa	Severe: floods, wetness.	Severe: floods	Severe: floods, wetness.	Severe: floods	Moderate: floods, wetness.
Zenda: [1]Za	Severe: floods, wetness.	Severe: floods	Severe: floods, wetness.	Severe: floods	Severe: low strength, wetness.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 8.—*Construction materials*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor"]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Albion: An	Good	Fair: excess fines	Fair: excess fines	Good.
Attica: At	Good	Poor: excess fines	Unsuited	Good.
Blanket: Ba	Poor: low strength	Unsuited: excess fines	Unsuited: excess fines	Fair: thin layer.
Carwile: Ca, [1]Cw	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Poor: thin layer.
Clark: Cx	Poor: low strength	Unsuited	Unsuited	Good.
Dillwyn:				
[1]Dp:				
Dillwyn part	Fair: wetness	Fair: excess fines	Unsuited	Poor: too sandy, wetness.
Plevna part	Poor: wetness	Fair: excess fines	Unsuited	Poor: wetness.
[1]Dt:				
Dillwyn part	Fair: wetness	Fair: excess fines	Unsuited	Poor: too sandy, wetness.
Tivoli part	Good	Fair	Unsuited: excess fines	Poor: too sandy.
Farnum: Fa, Fr	Poor: low strength	Unsuited	Unsuited	Good.
Kingman: Kg	Poor: wetness	Unsuited	Unsuited	Poor: wetness.
Naron: Na	Good	Poor: excess fines	Unsuited	Good.
Natrustolls: Nu	Moderate: wetness, low strength.	Unsuited: excess fines	Unsuited: excess fines	Fair: thin layer, excess salts.
Plevna: [1]Pa, [1]Pc	Poor: wetness	Fair: excess fines	Unsuited	Poor: wetness.
Pratt:				
Ph, Po	Good	Fair: excess fines	Unsuited	Poor: too sandy.
[1]Pr:				
Pratt part	Good	Fair: excess fines	Unsuited	Poor: too sandy.
Carwile part	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Poor: thin layer.
[1]Pt:				
Pratt part	Good	Fair: excess fines	Unsuited	Poor: too sandy.
Tivoli part	Good	Fair	Unsuited: excess fines	Poor: too sandy.
Tabler: Ta	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines	Fair: thin layer.
Tivoli: Tv	Good	Fair	Unsuited: excess fines	Poor: too sandy.
Waldeck: Wa	Fair: wetness	Fair: excess fines	Unsuited	Good.
Zenda: [1]Za	Poor: low strength	Unsuited	Unsuited	Good.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

soil and water conservation; relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or similar soil in other locations can be predicted; and predict the trafficability of soils for cross country movement of vehicles and construction equipment.

Data presented in this section are useful for land use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 to 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations and testing.

The information is presented mainly in tables. Table 7 shows, for each kind of soil, ratings of the degree and kind of limitations for building site development; table 6, for sanitary facilities; and table 9, for water management. Table 8 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil

TABLE 9.—*Water management*

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Albion: An	Seepage	Seepage	Not needed	Fast intake, erodes easily, slope.	Too sandy, rooting depth.	Droughty, rooting depth.
Attica: At	Seepage	Seepage	Not needed	Fast intake, soil blowing.	Soil blowing, erodes easily.	Erodes easily.
Blanket: Ba	Seepage	Piping, compressible.	Not needed	Favorable	Favorable	Favorable.
Carwile: Ca, [1]Cw	Favorable	Unstable fill, compressible.	Percs slowly, floods, poor outlets.	Slow intake, wetness.	Not needed	Percs slowly, wetness.
Clark: Cx	Seepage	Low strength, shrink-swell, erodes easily.	Not needed	Favorable	Erodes easily	Erodes easily.
Dillwyn:						
[1]Dp:						
Dillwyn part	Seepage	Seepage, erodes easily.	Wetness	Wetness	Not needed	Not needed.
Plevna part	Seepage	Seepage, erodes easily.	Floods, wetness	Floods, wetness	Not needed	Not needed.
[1]Dt:						
Dillwyn part	Seepage	Seepage, erodes easily.	Wetness	Wetness	Not needed	Not needed.
Tivoli part	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, erodes easily, droughty.	Complex slope, erodes easily, fast intake.	Erodes easily, droughty, seepage.
Farnum: Fa, Fr	Favorable	Low strength, shrink-swell.	Not needed	Slow intake	Favorable	Favorable.
Kingman: Kg	Wetness	Low strength, shrink-swell.	Floods, wetness	Floods, wetness	Not needed	Wetness.
Naron: Na	Seepage	Seepage	Not needed	Fast intake, erodes easily.	Erodes easily	Erodes easily.
Natrustolls: Nu	Seepage	Low strength	Excess salt, percs slowly, excess alkali.	Excess salt, slow intake, excess alkali.	Not needed	Not needed.
Plevna: [1]Pa, [1]Pc	Seepage	Seepage, erodes easily.	Floods, wetness	Floods, wetness	Not needed	Not needed.
Pratt:						
Ph, Po	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, soil blowing, fast intake.	Too sandy, complex slope, soil blowing.	Soil blowing, droughty.
[1]Pr:						
Pratt part	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, soil blowing, fast intake.	Too sandy, complex slope, soil blowing.	Soil blowing, droughty.
Carwile part	Favorable	Unstable fill, compressible.	Percs slowly, floods, poor outlets.	Slow intake, wetness.	Not needed	Percs slowly, wetness.
[1]Pt:						
Pratt part	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, soil blowing, fast intake.	Too sandy, complex slope, soil blowing.	Soil blowing, droughty.
Tivoli part	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, erodes easily, droughty.	Complex slope, erodes easily, fast intake.	Erodes easily, droughty, seepage.
Tabler: Ta	Slight	Moderate: unstable fill, compressible.	Percs slowly	Slow intake	Percs slowly	Percs slowly.

TABLE 9.—*Water management* — Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Tivoli: Tv	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, erodes easily, droughty.	Complex slope, erodes easily, fast intake.	Erodes easily, droughty, seepage.
Waldeck: Wa	Seepage	Seepage	Floods, wetness	Floods, wetness	Not needed	Not needed.
Zenda: [1]Za	Favorable	Low strength, shrink-swell, erodes easily.	Floods, wetness	Floods, wetness	Not needed	Not needed.

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

map, the soil descriptions, and other data provided in this survey can be used to make additional interpretations and to construct interpretive maps for specific land uses.

Some of the terms used in this soil survey have different meanings in soil science than they do in engineering. These terms are defined in the glossary.

Sanitary facilities

Favorable soil properties and site features are needed for the proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that deal with the ease of excavation or installation of these facilities will be of interest to contractors and local officials. The degree and kind of limitations of each soil for these uses and for use of the soil as daily cover for landfills is shown in table 6.

A limitation of *slight* means the soils are favorable for the specified use, and limitations are minor and easily overcome; *moderate* means soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and *severe* means soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance are required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between a depth of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and slippage are hazards if absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the tile lines. The absorption field does not adequately filter the effluent in these soils, and as a result ground water supplies in the area are susceptible to pollution. Soils that have a hazard of inadequate filtration are indicated by footnotes in table 6.

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity.

In many of the soils where the limitation for septic tank absorption fields is moderate or severe, it may be possible to install special systems that lower the seasonal water table or to increase the size of the absorption field so that satisfactory performance is achieved.

Sewage lagoons are shallow ponds constructed to hold sewage while bacteria decompose the solid and liquid wastes. Lagoons have a nearly level flow area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. They generally are designed so that depth of the sewage is 2 to 5 feet. Impervious soil at least 4 feet thick for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in content of organic matter and those that have stones and boulders are undesirable. Unless permeability is very slow, contamination of local ground water is a hazard in areas where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing solid waste, either in excavated trenches or on the surface of the

soil. The compacted waste is spread in layers and is covered by thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for sanitary landfill. The best soils are loamy or silty, are deep to bedrock and a seasonal water table, are free of large stones or boulders, and are not subject to flooding. Permeability is moderate or slow in these soils. In areas where the seasonal water table is high, water seeps into the trenches and causes problems in excavating and filling the trenches. Also, seepage into the refuse increases the risk of population of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 6 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill during both wet and dry weather. Loamy or silty soils that are free of stones or boulders are best suited to this use. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for final cover of landfill should be suitable for growing plants. In comparison with other horizons, the A horizon in most soils has the best workability, a higher content of organic matter, and the best potential for growing plants. Thus, for either the area or trench type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors that need to be evaluated are those that affect reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 7. A *slight* limitation indicates that soil properties are favorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and graves in cemeteries. Digging or trenching is influenced by wetness caused by a seasonal high water table, the texture and consistence of the soils, the tendency of the soils to cave in or slough, and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the descriptions of the soil series, the consistence of each horizon is defined, and the presence of very firm or extremely firm horizons that are generally difficult to excavate is indicated.

Dwellings and small commercial buildings are built on undisturbed soil and have foundation loads to support a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsistence from settling or shear failure of the foundation do not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink swell potential of the soil. Soil texture, plasticity and inplace density, potential frost action, wetness, and depth to a seasonal high water table were also considered. Wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and the large stones in or on the soil are also important considerations in the choice of sites for these structures. Susceptibiliy to flooding is a serious limitation.

Local roads and streets have an all weather surface that can carry light to medium traffic all year. They consist of subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The AASHTO and Unified classifications of the soil and the soil texture, density, and shrink-swell potential are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation and were also considered.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 8 by a rating of *good, fair,* or *poor*. Texture, thickness, and content of organic matter of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed

and described as the survey is made, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Since soil survey interpretations are oriented to local roads and streets rather than to highways, the ratings given in table 8 are evaluations of the soils as sources of roadfill for low embankments, generally less than 6 feet high, that are less exacting in design than high embankments. The upper part of the roadfill is considered as the subgrade (foundation) for the road. The ratings reflect the ease of excavating and working the material and the expected performance of the material after it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about soil properties that determine such performance is given in the descriptions of the soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 10 provide more specific information about the nature of each horizon that help determine its suitability as roadfill.

According to the Unified soil classification system, soils rated as *good* have a low shrink-swell potential, low potential of frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated as *fair* have a plasticity index of less than 15 and have such other limiting features as a moderate shrink-swell potential, moderate potential of frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated as *poor* regardless of the quality of the suitable material.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 8 indicate where to look for potential sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated as *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet from the surface. Coarse fragments of such soft bedrock material as shale and siltstone are not considered to be sand and gravel. Fine grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the descriptions of the soil series and in table 10.

Topsoil is used in areas where plant cover is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material when preparing a seedbed and by the ability of the soil material to sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

Soils rated as *good* have a surface layer of friable loamy material at least 16 inches thick. They are free of stones, low in content of gravel and other coarse fragments, and are gently sloping. These soils are low in soluble salts, which limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult most of the year.

Soils rated as *fair* are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick, or they are soils that have an appreciable amount of gravel, stones, or soluble salt.

Soils rated as *poor* are very sandy or very firm clayey soils that have suitable layers less than 8 inches thick; soils that have large amounts of gravel, stones, or soluble salt; steep soils; and soils that are poorly drained.

Although a rating of *good* is not based entirely on a high content of organic matter, a surface horizon is much preferred for topsoil because of its content of organic matter. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water management

Many soil properties and site features that affect water management practices have been identified previously in this soil survey. In table 9 soil and site features that affect water management are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have a low seepage potential, which is determined by the permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade its suitability for use in embankments, dikes, and levees.

Drainage of the soil is affected by such properties as permeability, texture, and structure; depth to the claypan or other layers that influence the rate of water movement; depth to the water table; slope and stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of drainage outlets.

Irrigation is affected by such features as slope, susceptibility to flooding, the hazards of water erosion and soil blowing, texture, presence of salts and alkali, maximum depth of the root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and to allow the water to soak into the soil or flow slowly through it to an outlet.

Features that affect suitability of a soil for terraces are uniformity of slope and steepness; depth to bedrock or other unfavorable material; permeability; ease of establishing plant cover; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff at nonerosive velocities to outlets. Features that affect the use of soils for grassed waterways are slope, permeability, erodibility, and suitability for permanent plant cover.

Soil Properties

Extensive data about the soil properties collected during the soil survey are summarized in this section. The two major sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of samples selected from representative profiles in the field.

When a soil scientist makes soil borings during field mapping he identifies important soil properties. He notes, for example, the seasonal soil moisture condition, or the presence of free water and its depth in the profile; the thickness of each soil horizon and its color; the texture, or the amount of clay, silt, sand, and gravel, or other coarse fragments in each horizon; the structure, or natural pattern of cracks and pores in the undisturbed soil; and the consistence of soil in place under the existing soil moisture conditions. He records the root depth of existing plants, determines soil pH (reaction), and identifies any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to characterize key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many of the soil series are available from nearby areas.

Based on summaries of available field and laboratory data, and listed in tables in this section, are estimated ranges in engineering properties and classifications and in physical and chemical properties for each major horizon of each soil in the survey area. Also, pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses are presented.

Engineering properties and classification

Estimates of engineering properties and classifications for the major horizons of each soil in the survey area are presented in table 10. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. Depth to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and in properties of each horizon is given for each soil series in the section "Descriptions of the Soils."

Texture is described in table 10 in standard terms used by the United States Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added; for example, "gravelly loam." Other texture terms used by USDA are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (USCS) and the system approved by the American Association of State Highway and Transportation Officials (AASHTO). In table 10 soils in the survey area are classified according to both systems.

The USCS classifies soils according to properties that affect their use as construction material (*2*). Soils are classified according to grain size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and content, and content of organic matter. Soils are grouped into 15 classes—eight classes of coarse grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example CL-ML.

The AASHTO system classifies soils according to those properties that affect their use in highway construction and maintenance (*1*). In this system a mineral soil is classified as one of seven basic groups ranging from A-1 through A-7 on the basis of grain size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine grained soils. Highly organic soils are classified as A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or more for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 13. The estimated classification, without group index numbers, is given in table 10. Also in table 10 the percentage of rounded pebbles more than 3 inches in diameter were estimated for the 30 to 60 inch horizon of Albion soils. These estimates are determined largely by observing percentage by volume, in the field, and then converting it to percentage by weight.

The percentage of the soil material less than 3 inches in diameter that passes each of four standard sieves is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field esti-

TABLE 10.—*Engineering properties and classifications*

[The symbol > means less than; < means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments >3 inches	Percentage passing sieve number— 4	10	40	200	Liquid limit	Plasticity index
	In				*Pct*					*Pct*	
Albion: An	0–10	Sandy loam	SM, ML	A–2, A–4	0	100	70–100	60–90	25–55	<30	NP–5
	10–20	Sandy loam, heavy sandy loam	SM, ML	A–2, A–4	0	50–100	45–100	45–90	30–55	<35	NP–20
	20–30	Coarse sandy loam, loamy sand	SM	A–2, A–1	0	50–100	45–90	40–70	15–30	<30	NP–5
	30–60	Loamy sand, gravelly sandy loam, gravelly sand.	SP–SM, GP–GM, SM, GM	A–2, A–1	0–5	40–100	40–90	30–70	5–30	<30	NP–5
Attica: At	0–10	Fine sandy loam	SM	A–2, A–4	0	100	95–100	70–100	20–50	<20	NP–3
	10–21	Fine sandy loam, sandy loam	SM, ML, SM–SC, CL–ML	A–2, A–4	0	100	95–100	75–100	30–35	<26	NP–6
	21–60	Fine sandy loam, loamy fine sand.	SM, SM–SC	A–2, A–4	0	100	95–100	70–100	20–50	<26	NP–6
Blanket: Ba	0–10	Silt loam	CL	A–6	0	95–100	95–100	90–100	60–80	28–40	12–24
	10–52	Clay loam, silty clay loam, clay, silty clay.	CL, CH	A–7	0	95–100	95–100	85–100	70–90	41–55	20–35
	52–60	Clay loam, clay, silty clay loam	CL	A–6, A–7	0	85–100	80–100	70–90	51–85	30–45	15–30
Carwile: Ca, [1]Cw	0–7	Fine sandy loam	ML, CL, CL–ML, SM, SC	A–4	0	100	98–100	94–100	36–85	<30	NP–10
	7–14	Clay loam, loam, sandy clay loam.	CL, SC, CL–ML	A–6, A–4, A–7	0	100	100	90–100	36–90	25–50	14–26
	14–32	Clay loam, clay, sandy clay	CL, CH, SC	A–6, A–7	0	100	100	90–100	40–95	35–70	14–38
	32–38	Clay loam, sandy clay loam, clay.	CL, CH, SC	A–4, A–6, A–7	0	100	100	90–100	36–95	25–70	7–38
	38–60	Fine sandy loam, sandy clay loam, clay.	CL, CH, SC, SM–SC, CL–ML	A–4, A–6, A–7	0	100	98–100	90–100	36–95	22–70	4–38
Clark: Cx	0–8	Loam	CL–ML, CL	A–4, A–6	0	100	95–100	90–100	50–90	20–40	5–20
	8–60	Loam, clay loam	CL	A–6, A–7–6	0	100	95–100	90–100	55–90	25–40	10–25
Dillwyn: [1]Dp:											
Dillwyn part	0–8	Loamy fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	70–100	5–35		NP
	8–60	Loamy fine sand, fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	70–100	5–35		NP
Plevna part	0–12	Fine sandy loam	SM	A–2, A–4	0	100	95–100	70–100	20–50	<20	NP–3
	12–38	Fine sandy loam, sandy loam	SM, SM–SC	A–2, A–4	0	100	95–100	70–100	30–50	<26	NP–6
	38–60	Fine sand, sand	SM, SP, SP–SM	A–2, A–3	0	100	90–100	50–90	4–35		NP
[1]Dt:											
Dillwyn part	0–8	Loamy fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	70–100	5–35		NP
	8–60	Loamy fine sand, fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	70–100	5–35		NP
Tivoli part	0–10	Loamy fine sand	SM, SP–SM	A–2, A–3	0	100	98–100	80–100	5–35		NP
	10–60	Fine sand, sand	SM, SP–SM	A–2, A–3	0	100	98–100	80–98	5–20		NP
Farnum: Fa	0–17	Fine sandy loam	SM, ML	A–4, A–2	0	100	100	80–100	30–55	<30	NP–5
	17–60	Clay loam, sandy clay loam, loam.	SC, CL, CH	A–6, A–7–6	0	100	100	65–100	45–80	35–55	10–25
Fr	0–22	Loam	CL–ML, CL	A–4, A–6	0	100	100	95–100	65–85	<30	5–15
	22–60	Clay loam, sandy clay loam, loam.	SC, CL, CH	A–6, A–7–6	0	100	100	65–100	45–80	35–55	10–30

Kingman: Kg	0–18	Silty clay loam	CL	A–6, A–7–6	0	100	100	95–100	90–100	35–50	13–26
	18–50	Silty clay loam	CL	A–6, A–7–6	0	100	100	95–100	90–100	35–50	13–26
	50–60	Sandy loam, clay loam, silty clay loam.	ML, CL, SM	A–6, A–4	0	100	95–100	90–100	40–90	<40	5–20
Naron: Na	0–13	Fine sandy loam	SM, SM–SC, ML, CL–ML	A–2, A–4	0	100	95–100	75–100	25–60	<26	1–7
	13–28	Fine sandy loam, sandy clay loam, loam.	SC, CL	A–4, A–6	0	100	95–100	80–100	36–60	26–40	8–18
	28–60	Fine sandy loam, loamy fine sand.	SM, SM–SC	A–2, A–4	0	100	95–100	75–100	20–50	<26	NP–7
Natrustolls: Nu	0–60	Loam, clay loam, fine sandy loam.	ML, SM, CL, SC	A–4, A–6	0	100	100	85–100	25–40	<35	NP–25
Plevna: [1]Pa, [1]Pc	0–12	Fine sandy loam	SM	A–2, A–4	0	100	95–100	70–100	20–50	<20	NP–3
	12–38	Fine sandy loam, sandy loam	SM, SM–SC	A–2, A–4	0	100	95–100	70–100	30–50	<26	NP–6
	38–60	Fine sand, sand	SM, SP	A–2, A–3	0	100	90–100	50–90	4–35		NP
Pratt: Ph, Po	0–8	Loamy fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	70–100	17–35		NP
	8–28	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM–SC	A–2, A–4	0	100	95–100	90–100	15–40	<20	NP–6
	28–60	Loamy fine sand, fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	80–100	5–35		NP
[1]Pr: Pratt part	0–8	Loamy fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	70–100	7–35		NP
	8–28	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM–SC	A–2, A–4	0	100	95–100	90–100	15–40	<20	NP–6
	28–60	Loamy fine sand, fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	80–100	5–35		NP
Carwile part	0–7	Fine sandy loam	ML, CL, CL–ML, SM, SC	A–4	0	100	98–100	94–100	36–85	<30	NP–10
	7–14	Clay loam, loam, sandy clay loam.	CL, SC, CL–ML	A–6, A–7	0	100	100	90–100	36–90	25–50	14–26
	14–32	Clay loam, clay, sandy clay	SL, CH, SC	A–6, A–7	0	100	100	90–100	40–95	35–70	14–38
	32–38	Clay loam, sandy clay loam, clay.	CL, CH, SC	A–4, A–6, A–7	0	100	100	90–100	36–95	25–70	7–38
	38–60	Fine sandy loam, sandy clay loam, clay.	CL, CH, SC, SM–SC, CL–ML	A–4, A–6, A–7	0	100	98–100	90–100	36–95	22–70	4–38
[1]Pt: Pratt part	0–8	Loamy fine sand	SM, SP–SM	A–2, A–3	0	100	95–100	70–100	7–35		[2]NP
	8–28	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM–SC	A–2, A–4	0	100	95–100	90–100	15–40	<20	NP–6
	28–60	Loamy fine sand, fine sand	SM, SP–SM	A–3	0	100	95–100	80–100	5–35		NP
Tivoli part	0–10	Loamy fine sand	SM, SP–SM	A–2, A–3	0	100	98–100	80–100	5–35		NP
	10–60	Fine sand, sand	SM, SP–SM	A–2, A–3	0	100	98–100	80–98	5–20		NP
Tabler: Ta	0–7	Loam, clay loam	CL, ML, CL–ML	A–4, A–6	0	100	100	96–100	80–98	20–40	3–18
	7–48	Silty clay, clay	CL, CH	A–7	0	100	100	96–100	90–99	41–65	18–35
	48–60	Silty clay, clay, silty clay loam, clay loam.	CL, CH	A–7, A–6	0	96–100	96–100	92–100	80–99	33–60	13–33
Tivoli: Tv	0–6	Fine sand	SM, SP–SM	A–2, A–3	0	100	98–100	80–100	5–35		NP
	6–60	Fine sand, sand	SM, SP–SM	A–2, A–3	0	100	98–100	80–98	5–20		NP
Waldeck: Wa	0–20	Fine sandy loam, loam	SM, SM–SC, ML, CL–ML	A–2, A–4	0	100	95–100	75–100	25–55	<25	NP–5
	20–30	Fine sandy loam, sandy loam	SM, SM–SC	A–2, A–4	0	100	95–100	70–100	30–50	<25	NP–5
	30–60	Fine sand, sand	SM, SP	A–1, A–2, A–3	0	90–100	80–100	40–60	1–35		NP

TABLE 10.—*Engineering properties and classifications*—Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments >3 inches	Percentage passing sieve number—				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				*Pct*					*Pct*	
Zenda: [1]Za	0-20	Loam	CL-ML, CL	A-4, A-6	0	100	95-100	85-100	55-80	25-40	5-20
	20-54	Loam, clay loam	CL	A-6	0	100	95-100	85-100	55-80	25-40	10-25
	54-60	Loamy fine sand	SM, SP-SM	A-2, A-4	0	100	95-100	90-100	15-40	<20	NP-6

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.
[2]NP = nonplastic.

mates derived from many borings made during the survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistency of the soil. These indexes are used in both the USCS and the AASHTO classification systems. They are also used as indicators in making general predictions of soil behavior.

The range in liquid limit and plasticity index is estimated on the basis of test data from the survey area or from nearby areas and on observations of the soil borings made during the survey.

Physical and chemical properties

Table 11 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depth indicated, in the representative profile of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships between the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for water movement in a vertical direction when the soil is saturated. Not considered in the estimates are lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and design of drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as the range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops and ornamental or other plants to be grown, in evaluating soil amendments for fertility and stabilization, and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 11. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode

TABLE 11.—*Physical and chemical properties of soils*

[Dashes indicate data were not available. The symbol < means less than. The erosion tolerance factor (T) is for the entire profile. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*						
Albion: An	0–10	2.0–6.0	0.13–0.20	5.6–6.5	<2	Low	Low	Low	0.20	3	3
	10–20	2.0–6.0	0.12–0.18	5.6–6.5	<2	Low	Low	Moderate	0.20		
	20–30	2.0–6.0	0.09–0.12	5.6–6.5	<2	Low	Low	Low	0.15		
	30–60	6.0–20	0.03–0.10	6.1–7.8	<2	Low	Low	Low	0.15		
Attica: At	0–10	2.0–6.0	0.16–0.18	5.6–7.3	<2	Low	Low	Low	0.24	5	3
	10–21	2.0–6.0	0.12–0.17	5.6–6.5	<2	Low	Low	Low	0.24		
	21–60	2.0–6.0	0.08–0.16	6.1–7.8	<2	Low	Low	Low	0.24		
Blanket: Ba	0–10	0.6–2.0	0.15–0.20	6.1–7.3	<2	Moderate	High	Low	0.37	5	
	10–52	0.2–0.6	0.12–0.18	6.6–8.4	<2	Moderate	High	Low	0.28		
	52–60	0.6–2.0	0.12–0.18	7.9–8.4	<2	Moderate	High	Low	0.28		
Carwile: Ca, [1]Cw	0–7	0.6–2.0	0.11–0.20	5.6–7.3	<2	Low	Moderate	Moderate	0.32	5	3
	7–14	0.2–2.0	0.12–0.20	6.1–7.3	<2	Moderate	High	Moderate	0.37		
	14–32	0.06–0.2	0.12–0.20	6.1–7.8	<2	High	High	Low	0.32		
	32–38	0.2–2.0	0.12–0.20	6.6–8.4	<2	High	High	Low	0.28		
	38–60	0.2–2.0	0.11–0.18	7.9–8.4	<2	High	High	Low	0.28		
Clark: Cx	0–8	0.6–2.0	0.17–0.22	7.4–8.4	<2	Moderate	Moderate	Low	0.28	5	4L
	8–60	0.6–2.0	0.15–0.19	7.9–8.4	<2	Moderate	Moderate	Low	0.28		
Dillwyn:											
[1]Dp:											
Dillwyn part	0–8	6.0–20	0.08–0.12	5.6–7.3	<2	Low	Low	Low		5	2
	8–60	6.0–20	0.06–0.10	5.6–7.8	<2	Low	Low	Low			
Plevna part	0–12	2.0–6.0	0.14–0.18	6.1–7.3	<2	Low	High	Low			3
	12–38	2.0–6.0	0.12–0.16	6.6–8.4	<2	Low	High	Low			
	38–60	2.0–6.0	0.05–0.07	6.6–8.4	<2	Low	High	Low			
[1]Dt:											
Dillwyn part	0–8	6.0–20	0.08–0.12	5.6–7.3	<2	Low	Low	Low		5	2
	8–60	6.0–20	0.06–0.10	5.6–7.8	<2	Low	Low	Low			
Tivoli part	0–10	6.0–20	0.05–0.11	6.1–7.3	<2	Low	Low	Low	0.17	5	1
	10–60	6.0–20	0.02–0.06	6.1–7.8	<2	Low	Low	Low	0.17		
Farnum:											
Fa	0–17	0.6–2.0	0.13–0.21	5.6–7.3	<2	Low	Low	Low	0.20	5–4	3
	17–60	0.2–0.6	0.14–0.21	6.6–8.4	<2	Moderate	Moderate	Low	0.37		
Fr	0–22	0.6–2.0	0.20–0.22	5.6–7.3	<2	Low	Low	Low	0.37	5–4	6
	22–60	0.2–0.6	0.14–0.21	6.1–8.4	<2	Moderate	Moderate	Low	0.28		
Kingman: Kg	0–18	0.2–0.6	0.21–0.23	7.4–8.4	<2	Moderate	High	Low			4L
	18–50	0.2–0.6	0.18–0.20	7.4–8.4	<2	Moderate	High	Low			
	50–60	0.2–2.0	0.12–0.19	7.4–8.4	<2	Low	High	Low			
Naron: Na	0–13	0.6–6.0	0.14–0.20	5.6–7.3	<2	Low	Low	Low	0.20	5	3
	13–28	0.6–2.0	0.15–0.18	5.6–7.8	<2	Low	Low	Low	0.32		
	28–60	0.6–6.0	0.10–0.15	6.1–8.4	<2	Low	Low	Low	0.32		

TABLE 11.—*Physical and chemical properties of soils*—Continued

Soil name and map symbol	Depth	Perme-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodi-bility group
							Uncoated steel	Concrete	K	T	
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*						
Natrustolls: Nu	0–60	0.6–6.0	0.15–0.22	6.1–8.4	2–16	Low to moderate.	High	Low to moderate.			3
Plevna: [1]Pa, [1]Pc	0–12	2.0–6.0	0.14–0.18	6.1–7.3	<2	Low	High	Low			3
	12–38	2.0–6.0	0.12–0.16	6.6–8.4	<2	Low	High	Low			
	38–60	2.0–6.0	0.05–0.07	6.6–8.4	<2	Low	High	Low			
Pratt:											
Ph, Po	0–8	6.0–20	0.10–0.13	5.6–7.3	<2	Low	Low	Moderate	0.17	5	2
	8–28	6.0–20	0.09–0.16	5.6–7.3	<2	Low	Low	Low	0.17		
	28–60	6.0–20	0.08–0.12	6.1–7.3	<2	Low	Low	Low	0.17		
[1]Pr:											
Pratt part	0–8	6.0–20	0.10–0.13	5.6–7.3	<2	Low	Low	Moderate	0.17	5	2
	8–28	6.0–20	0.09–0.16	5.6–7.3	<2	Low	Low	Low	0.17		
	28–60	6.0–20	0.08–0.12	6.1–7.3	<2	Low	Low	Low	0.17		
Carwile part	0–7	0.6–2.0	0.11–0.20	5.6–7.3	<2	Low	Moderate	Moderate	0.32	5	3
	7–14	0.2–2.0	0.12–0.20	6.1–7.3	<2	Moderate	High	Moderate	0.37		
	14–32	0.06–0.2	0.12–0.20	6.1–7.8	<2	High	High	Low	0.32		
	32–38	0.2–2.0	0.12–0.20	6.6–8.4	<2	High	High	Low	0.28		
	38–60	0.2–2.0	0.11–0.18	7.9–8.4	<2	High	High	Low	0.28		
[1]Pt:											
Pratt part	0–8	6.0–20	0.10–0.13	5.6–7.3	<2	Low	Low	Moderate	0.17	5	2
	8–28	6.0–20	0.09–0.16	5.6–7.3	<2	Low	Low	Low	0.17		
	28–60	6.0–20	0.08–0.12	6.1–7.3	<2	Low	Low	Low	0.17		
Tivoli part	0–10	6.0–20	0.05–0.11	6.1–7.3	<2	Low	Low	Low	0.17	5	1
	10–60	6.0–20	0.02–0.06	6.1–7.8	<2	Low	Low	Low			
Tabler: Ta	0–7	0.2–0.6	0.15–0.24	6.1–7.8	<2	Low	Moderate	Low	0.43	5	
	7–48	<0.06	0.12–0.18	6.6–7.8	<2	High	High	Low	0.37		
	48–60	<0.06	0.12–0.22	7.4–8.4	<2	High	High	Low	0.37		
Tivoli: Tv	0–6	6.0–20	0.05–0.11	6.1–7.3	<2	Low	Low	Low	0.17	5	1
	6–60	6.0–20	0.02–0.06	6.1–7.8	<2	Low	Low	Low			
Waldeck: Wa	0–20	2.0–6.0	0.14–0.18	7.4–8.4	<2	Low	Moderate	Low			3
	20–30	2.0–6.0	0.12–0.17	7.4–8.4	<2	Low	Moderate	Low			
	30–60	6.0–20	0.05–0.07	7.4–8.4	<2	Low	Moderate	Low			
Zenda: [1]Za	0–20	0.6–2.0	0.17–0.22	6.6–8.4	<2	Moderate	High	Low			6
	20–54	0.6–2.0	0.15–0.19	7.4–8.4	<2	Moderate	High	Low			
	54–60	6.0–20	0.05–0.07	7.4–8.4	<2	Low	Low	Low			

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others it was estimated on the basis of the kind of clay and on measurements of similar soils. Size of imposed loadings and the magnitude of changes in soil moisture content are also important factors that influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A *high* shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion, as used in table 11, pertains to potential soil induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle size distribution, total acidity, and electrical conductivity of the soil material. The rating of soils for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity. Protective measures for steel or more resistant concrete help avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

Sands, coarse sands, fine sand, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Features that relate to runoff or infiltration of water, to flooding, and to grading and excavation of each soil are indicated in table 12. This information is helpful in planning land uses and engineering projects that are likely to be affected by runoff from watersheds, by flooding and a seasonal high water table, or by the presence of bedrock in the upper 5 to 6 feet of the soil.

Hydrologic groups are used to estimate runoff after rainfall. Soil properties that influence the minimum rate of infiltration into the bare soil after prolonged wetting are depth to the water table, water intake rate and permeability after prolonged wetting, and depth to slowly permeable or very permeable soil material.

Flooding is rated in general terms that describe the frequency, duration, and period of the year when flooding is most likely to occur. The ratings are based on such evidence in the soil profile of the effects of flooding as thin strata of gravel, sand, silt, or (in places) clay deposited by flood water; irregular decrease in content of organic matter as depth increases; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about flood water heights and the extent of flooding; and local knowledge that relates the unique landscape position of each soil to historic floods. Most soils in low positions on the landscape where flooding is likely to occur are classified as fluvents at the suborder level or as fluventic subgroups. See the section "Classification" for more information.

The generalized description of flood hazards is of value in land use planning, and it provides a valid basis for land use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood prone areas at

TABLE 12.—*Soil and water features*

[Absence of an entry indicates the feature is not a concern. The symbol > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			*In*	
Albion: An	B	None			>6.0			>60	
Attica: At	B	None			>6.0			>60	
Blanket: Ba	C	None			>6.0			>60	
Carwile: Ca, [1]Cw	D	Occasional	Brief to very long.	Apr.–Oct.	0–2.0	Apparent	Oct.–Apr.	>60	
Clark: Cx	B	None			>6.0			>60	
Dillwyn:									
[1]Dp:									
Dillwyn part	A	None			1.0–5.0	Apparent	Jan.–Dec.	>60	
Plevna part	D	Frequent	Brief to long	Mar.–Oct.	0–4.0	Apparent	Jan.–Dec.	>60	
[1]Dt:									
Dillwyn part	A	None			1.0–5.0	Apparent	Jan.–Dec.	>60	
Tivoli part	A	None			>6.0			>60	
Farnum: Fa, Fr	B	None			>6.0			>60	
Kingman: Kg	D	Occasional	Very brief	Jan.–Dec.	0.5–2.0	Apparent	Dec.–Mar.	>60	
Naron: Na	B	None			>6.0			>60	
Natrustolls: Nu	C	Rare to occasional.	Very brief	Mar.–Oct.	2.0–6.0	Apparent	Nov.–May	>60	
Plevna: [1]Pa, [1]Pc	D	Frequent	Brief to long	Mar.–Oct.	0–4.0	Apparent	Jan.–Dec.	>60	
Pratt:									
Ph, Po	A	None			>6.0			>60	
[1]Pr:									
Pratt part	A	None			>6.0			>60	
Carwile part	D	Occasional	Brief to very long.	Apr.–Oct.	0–2.0	Apparent	Oct.–Apr.	>60	
[1]Pt:									
Pratt part	A	None			>6.0			>60	
Tivoli part	A	None			>6.0			>60	
Tabler: Ta	D	None			2.5–3.5	Perched	Oct.–Apr.	>60	
Tivoli: Tv	A	None			>6.0			>60	
Waldeck: Wa	C	Occasional	Brief	Mar.–Oct.	2.0–6.0	Apparent	Oct.–Apr.	>60	
Zenda: [1]Za	C	Occasional	Very brief	Apr.–Sept.	2.0–6.0	Apparent	Oct.–Apr.	>60	

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

specific flood frequency levels.

A high water table is the highest level of a saturated zone more than 6 inches thick in soils for continuous period of more than 2 weeks in most years. The depth to a high water table applies to undrained soils. Estimates are generally based on the relationship between grayish colors or mottles in the soil and the depth to free water observed during the course of the soil survey. Indicated are the depth to the high water table; the kind of water table, whether it is perched, artesian, or the upper part of the ground water table; and the months of the year that the high water commonly is present. Only those saturated zones above a depth of 5 or 6 feet are indicated.

Information about the high water table helps in assessing the need for specially designed foundations, specific kinds of drainage systems, and footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements and to determine how septic tank absorption fields and other underground installations will function. Also, a high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 4 to 6 feet or less.

For many soils, a limited range in depth to bedrock is a part of the definition of the soil series. The depth shown is based on measurements made in soil borings and observations made during the soil mapping. The kind of bedrock and its relative hardness as related to the ease of excavation is also shown. Rippable bedrock can be excavated with a single tooth ripping attachment on a 200 horsepower tractor, but hard bedrock generally requires blasting.

Soil test data

Table 13 contains engineering test data for some of the major soil series in Stafford County. These tests were made to help evaluate the soils for engineering uses. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction data (moisture density data) are important in earthwork. If a soil material is compacted at a successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture* content is reached. After that, density decreases as the moisture content increases. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine the liquid limit and plastic limit measure the effect of water on the consistence of the soil material as has been explained for table 10.

Formation and Classification of Soils

This section consists of two main parts. In the first part the factors that affected the formation of soils in Stafford County are explained, and in the second the current system of soil classification is explained and the soil series represented in the county are placed in some classes of that system.

Factors of Soil Formation

Soil is produced by the action of soil forming processes on materials deposited or altered by geologic forces. The characteristics of the soil at any given point in the time of their formation are determined by the physical and mineralogical composition of the parent material, the *climate* that has existed during and since the accumulation of soil material, the *plant and animal life* on and in the soil, the *relief* or lay of the land, and the length of *time* the processes of soil formation have acted on the soil material.

The climate, plant life, and animal life, particularly plant life, are active factors of soil formation. These factors have a combined effect. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body of soil having genetically related horizons. The effects of climate, plants, and animals on the formation of horizons in soils are conditioned by relief. The parent material also affects the kind of soil profile that is formed and in some places may be the predominant factor. Finally, time is needed for changing the parent material into soil that has genetic horizons. Usually a long time is required for the formation of distinct horizons.

Parent material

Parent material consists of the weathered rock or partly weathered material from which soils are formed. Weathering of rocks takes place through the process of freezing and thawing, abrasion and soil blowing, water and glaciers acting on the soil, and by chemical processes.

Unconsolidated deposits of silt, sand, and gravel (Meade formation) of early Pleistocene age entirely covers Stafford County (*10*). Quaternary material, much of it sandy, covers the surface of the county. Recent alluvium is the parent material for all soils formed on flood plains and stream terraces of the major streams in the county and in Big Marsh and Little Marsh areas.

Climate

Climate influences both physical and chemical weathering processes and the biological forces at work within the parent material. The downward movement of water is the major factor in transforming the parent material into a soil that has distinct horizons. The amount of water that percolates through the soil depends on the temperature, the type and intensity of precipitation and humidity, the relief, and the nature of the soil material. Soil forming processes are most active when the soil is warm and moist. In Stafford County these processes are most active in spring and summer. Soil structure is modified by freezing and thawing and by wetting and drying. These processes tend to form aggregates in soils. Alternate wetting and drying is active in the subhumid climate of the county.

Climate is an important factor in causing differences in soils over a wide region. Because of climate, however, the differences in the soils in Stafford County are negligible.

The average annual rainfall is between 24 and 25 inches in Stafford County. Wind velocity in the county is high and influences soil formation by sorting and moving soil material. The prevailing wind direction is southerly to northerly.

Plants and animals

Plants and animals have an important effect on the formation of soils. Plant and animal remains furnish organic matter to the soil. Growing plants and animals, including bacteria and other microscopic animals, transform and decompose organic matter, mix the soil material, use and release nutrients, and help to weather rocks. Many kinds of plants and animals grow and die in the soil and thus influence the physical, chemical, and biological characteristics of the soil.

TABLE 13.—*Engineering*

[Tests performed by the State Highway Commission of Kansas in accordance with standard procedures of the American Associa-

Soil name and location	Parent material	Report no.	Depth	Moisture density[1]	
				Maximum dry density	Optimum moisture
			Inches	*Pound per cubic foot*	*Percent*
Attica fine sandy loam:	Eolian sediment	S73 Kans			
2,490 feet east and 300 feet south of the northwest corner of sec. 2, T. 24 S., R. 15 W. (Modal)		93–4–1	0–10	115	11
		93–4–2	10–21	116	12
		93–4–3	39–60	115	13
Naron fine sandy loam:	Eolian sediment	S73 Kans			
660 feet north and 270 feet west of the southeast corner of sec. 35, T. 23 S., R. 14 W. (Modal)		93–5–1	0–8	121	11
		93–5–2	13–28	118	12
		93–5–3	38–60	120	11
Carwile fine sandy loam:	Old alluvium	S73 Kans			
2,376 feet west and 563 feet south of the northeast corner of sec. 13, T. 23 S., R. 12 W. (Modal)		93–6–1	0–8	115	12
		93–6–2	23–45	104	20
		93–6–3	53–60	111	14

[1]Based on the moisture density relations of soils using 5.5 lb rammer and 12 in drop, AASHTO Designation T99-61, Method A, with the following variations: (1) All material is ovendried at 230°F; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

[2]Mechanical analyses according to the AASHTO Designation T88-57 with the following variations: (1) All material is ovendried at 230°F and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2. (The maximum time is 15 minutes, and the minimum time is 1 minute.) Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey precedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain sized fractions are calculated on the basis of

Plants and animals in the soil and plants growing on the soil make it more permeable to water, promote leaching, and improve soil structure. Burrowing animals, insects, and earthworms mix and move large quantities of soil material and bring fresh minerals into the surface horizon in many places.

The soils of Stafford County formed mostly under prairie grasses. Grasses return large amounts of organic matter to the soil material in both roots and tops. Thus, in addition to other soil forming factors, the surface layer and subsoil is darkened as time passes, the soil structure is formed, and a distinct soil profile emerges.

Relief

Relief influences soil formation through its effect on drainage, runoff, erosion, and soil temperature. Through its effect on soil moisture and temperature, relief also influences the kinds of plants and animals that live on and in the soil. In areas of more sloping relief where runoff is rapid, the soil material is likely to be washed away before well developed horizons can form. In areas of nearly level relief and in depressions, erosion is slight and the soil receives extra water as runoff. The soils are deep, and their horizons are well developed in these areas.

Stafford County has four major types of relief—nearly level, undulating, hummocky, and hilly land. Most of the county ranges over a repeating sequence of relief that ranges from nearly level to hummocky. Small areas of nearly level relief are along major streams and near Big Marsh and Little Marsh areas. Present stream channels and old meandering channels furnish sharp micro-relief in these areas. Another small area of nearly level and gently sloping relief is near the town of Stafford. Three distinctly hilly sandy areas are south of Macksville, east of St. John, and in the northeastern part of the county near the Barton County line.

In some instances a soil will always be in areas of one particular kind of relief, but in many instances the same kind of soil occurs in different areas that have different relief. For example, Tivoli fine sand is only on hilly dune land. Pratt loamy fine sand, on the other hand, is on both undulating and hummocky relief.

Time

Time is needed for soils to form from parent materials. Some soils form rapidly while others form slowly. The length of time needed depends largely on the other factors of soil formation. Formation of horizons in a soil, therefore, is related to time. As water moves downward in the soil, soluble matter and fine particles are leached from the surface layer and are deposited

test data

tion of State Highway and Transportation Officials (AASHTO) except as otherwise noted]

Mechanical analysis[2]							Liquid limit	Plasticity index	Classification	
Percentage less than 3 inches in diameter passing sieve—			Percentage smaller than						AASHTO[3]	Unified[4]
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
100	98	25	18	11	8	6	18	1	A-2-4 (0)	SM
100	98	27	22	16	13	11	21	3	A-2-4 (0)	SM
....	100	33	27	20	16	13	22	5	A-2-4 (0)	SM-SC
100	91	34	27	17	12	10	19	4	A-2-4 (0)	SM-SC
100	93	46	40	28	18	14	25	10	A-4 (2)	SC
100	91	22	17	12	9	8	18	3	A-2-4 (0)	SM
100	97	56	45	26	13	11	21	5	A-4 (4)	CL-ML
100	99	88	81	62	39	31	49	31	A-7-6 (18)	CL
100	98	70	60	41	26	19	32	16	A-6 (9)	CL

all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain sized fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3]Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed 8): The Classification of Soils and Soil Aggregate Mixtures for Highway Construction purposes, AASHTO Designation M145-49.

[4]Based on the Unified Soil Classification System Technical Memorandum No. 3-357, Volume 1, Waterways Experiment Station, Corps of Engineers, March 1953. The SCS and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two "points" from A-line to be given a borderline classification obtained by this use is CL-ML.

in the subsoil. How long this process of leaching takes depends mostly on how long the soil material has been in place; how much water penetrates and is able to move through the soil; and how much the chemical, physical, and biological activity assists the process.

Some soils, such as Tivoli, lack horizon development because the soil material in which they formed is highly resistant to weathering. Other soils, such as Waldeck, formed in recent alluvium, but they have had little time to form distinct genetic horizons. Naron soils formed in loamy and sandy eolian deposits. These soils have been exposed to soil forming processes for thousands of years and have distinct horizons. They are referred to as "mature" soils.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*11*).

The system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the bases for classification are the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 14 the soils of Stafford County are classified according to the system. Classes of the system are briefly discussed in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil forming processes that have taken place.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and that are important to plant growth or that were selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order.

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. The name of a great group ends with the name of a suborder.

SUBGROUP. Each great group is divided into three subgroups; the central (typic) concept of the great groups, which is not necessarily the most extensive

TABLE 14.—*Classification of the soils*

Soil name	Family or higher taxonomic class
Albion	Coarse-loamy, mixed, thermic Udic Argiustolls.
Attica	Coarse-loamy, mixed, thermic Typic Haplustalfs.
Blanket	Fine, mixed, thermic Pachic Argiustolls.
Carwile	Fine, mixed, thermic Typic Argiaquolls.
Clark	Fine-loamy, mixed, thermic Typic Calciustolls.
Dillwyn	Mixed, thermic Aquic Ustipsamments.
Farnum	Fine-loamy, mixed, thermic Pachic Argiustolls.
Kingman	Fine-silty, mixed (calcareous), thermic Fluvaquentic Haplaquolls.
Naron	Fine-loamy, mixed, thermic Udic Argiustolls.
Natrustolls	Fine-loamy, mixed, thermic Leptic Natrustolls and Typic Natrustalfs.
Plevna	Coarse-loamy, mixed, thermic Fluvaquentic Haplaquolls.
Pratt	Sandy, mixed, thermic Psammentic Haplustalfs.
Tabler	Fine, montmorillionitic, thermic Vertic Argiustolls.
Tivoli	Mixed, thermic Typic Ustipsamments.
Waldeck	Coarse-loamy, mixed, thermic Fluvaquentic Haplustolls.
Zenda	Fine-loamy, mixed, thermic Fluvaquentic Haplustolls.

subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades that have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle size distribution, mineral content, temperature regime, thickness of the soil material penetrable by roots, consistence, moisture equivalent, slope, and presence of permanent cracks.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and have horizons, that except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

General Facts About the County

History and development.—Stafford County was established in 1897. It was named in honor of Lewis Stafford, an infantry captain during the Civil War. When the Civil War ended in 1865, Stafford County was a part of a larger area called Marion County. The present Stafford, Barton, and Pratt Counties were set aside as a three county area in 1868, but settlement of Stafford County began about 1874. St. John developed in the period 1877 to 1880. It became the county seat in 1882, and a brick courthouse was built in 1886.[8] Railroads were built across the Stafford, Barton, and Pratt County area in the period 1868 to 1872. The Santa Fe Railroad reached Great Bend August 5, 1872, as this project moved westward.

Oil and gas.—Stafford County joined the growing list of oil producèrs about 1930 (*10*). The Richardson pool was the initial discovery in Stafford County. Many good and high producing oil and gas pools were drilled in Stafford County. The average depth was about 3,736 feet, and oil strata of Pennsylvania, Mississippian and Ordovician rocks were tapped. The largest producer wells were from the Arbuckle group of the Ordovician age.

Water resources.—Most of the domestic stock-water wells and all irrigation wells derive water from the Meade formation (*10*). In northeastern Stafford County the ground water is high in mineral content and is not satisfactory for most uses.

Soils in sandy areas of Stafford County and in the many low areas and intermittent lakes allow much water to accumulate and percolate downward to the water table. In some areas clayey layers hinder downward movement of water, but these layers are limited in horizontal extent, and water detours around them to reach the water table. Water commonly stands in low areas after rains. In the dryer seasons most of this water evaporates. The rest of the average annual rainfall of slightly more than 24 inches is accounted for by transpiration during plant growth.

In Stafford County there are 240 gravity and sprinkler irrigation systems. They supply water at rates ranging from 800 to 1,500 gallons per minute. Several irrigation systems are developed every year.

Sand and gravel.—Thick sand and gravel deposits are in the Meade formation in Stafford County (*10*). This formation is exposed in some places at the surface along Rattlesnake Creek, the North Fork of the Ninnescah River, and around Big Marsh. Elsewhere the Meade formation is covered by dune sand a few feet to more than 50 feet thick.

Salt. According to oil well logs, a bed of rock salt 50 to 200 feet thick is about 1,000 feet below the surface nearly everywhere in the county. This salt is referred to as the Hutchinson salt member of the Wellington formation (Permain) (*7*). In 1868 a salt plant was built at Big Salt Marsh to procure salt from the water of the marsh. Salt from this plant was sold locally, and it was used primarily for curing meat.

Volcanic ash of very good textural quality is exposed in a small area in sec. 28, T. 25 S., R. 11 W. (*10*).

Physiography, Relief, and Drainage

All of Stafford County is in the Arkansas River Lowlands section of the Central Lowland physiographic province of the United States. The region of Central Kansas, including Stafford County along the Arkansas River Valley, is the most extensive part of the Meade formation in the State (*6*). The Meade formation in this area consists largely of sand and gravel. The Grand Island member is the lower and intermediate part which filled the old valleys in the bedrock and is overlain by Illinoian Crete gravels and Wisconsinan dune sand and alluvium (*10*).

[8]STEELE, FRANK L., from his notes on "A History of Stafford County" in the Memorial Library, St. John, Kansas.

The present ground surface has little sharp relief except in hilly, sandy areas that occur south of Macksville, east of St. John, and in the northeastern part of the county. The larger part of the remaining area of the county is a reoccurring sequence of nearly level, undulating, and hummocky landscapes. Among these landscapes are many low areas throughout the county where runoff is slow or very slow and where the drainage pattern is lacking or is poorly defined. Three main drainage patterns are in Stafford County. They are Rattlesnake Creek and Wild Horse Creek, Peace Creek, the North Fork of the Ninnescah River and an unnamed creek that is locally called "S Creek." Rattlesnake Creek flows to the northeast and crosses the county from the southwest corner to the northeast and crosses the county from the southwest corner to the northeast corner. It passes through Quivira National Wildlife Refuge.

Prior to establishment of the refuge, Rattlesnake Creek passed within about one-half mile of Little Salt Marsh, but now it is mostly diverted through the marsh. The average gradient of Rattlesnake Creek above St. John is about 7 feet to the mile, and below St. John the gradient is about 4 feet to the mile (*10*). Wild Horse Creek flows to the northeast and drains a small area between Macksville and a point about 3 miles north of St. John where it enters Rattlesnake Creek. The many branched Peace Creek drains the nearly level and gently sloping Blanket-Farnum association to the northeast of Stafford. It enters Reno County a little more than 2 miles south of Little Salt Marsh. The North Fork of the Ninnescah River heads in the uplands about 12 miles west of the southeast corner of the county. It flows to the northeast and enters Reno County about 6 miles north of the southeast corner of the county. S Creek drains a small area to the southeast of Stafford where it joins the North Fork of the Stafford-Reno County line.

The highest elevation in Stafford County is 2,050 feet at a point west of Macksville, and the lowest is about 1,725 feet where Rattlesnake Creek crosses the Stafford-Rice County line.

Climate[9]

Stafford County has a typical continental type of climate as a result of its location in the interior of a large land mass in middle latitudes. Continental climates are characterized by large diurnal and annual variations in temperature. This climatic feature is characteristic of Kansas and, indeed, of most of the area between the Rocky Mountains to the west and the Appalachian Mountains to the east.

The climate of Stafford County has been classified by Thornwaite (*12*) as "dry subhumid." Precipitation in such a climate, "does not exceed the losses by evaporation and the needs of plants, and no water is available as surface runoff. As a consequence, there is no accretion to ground water except in rainy years, and the subsoil is virtually permanently dry." Although this classification describes Stafford County under average conditions, there are occasional years that have large rainfall totals. Stafford County is near the boundary between the dry portion of western Kansas that is influenced by the rain shadow of the Rockies and the moist eastern regions of the state that are frequently visited by moisture laden air currents from the Gulf of Mexico (*4*). The annual rainfall depends on the outcome of the conflict between these two influential factors.

Precipitation records have been essentially continuous at Hudson since 1922. The current record of temperature at Hudson began in 1951. The description of the climate for Stafford County given in table 15 is based on an analysis of the Hudson records and those of nearby Larned in Pawnee County.

Precipitation totals for the year in Stafford County average about 25 inches. More than eighteen inches, or about 75 percent of this annual total occurs in the growing season of April through September. There are measurable amounts of precipitation on an average of 74 days a year. May and June, with a total of nine, have the highest average number of rainy days per month. These months also have the highest average amounts of precipitation. The heaviest one day rainfall at Hudson was 7.77 inches on September 25, 1973. Precipitation on a majority of the rainy days is very light. Nearly 50 percent of the rainy days have less than 0.25 inch. Only about 10 percent of the rainy days have a total of more than one inch. The 11 days that have the greatest precipitation totals contribute 50 percent of the annual total. The remaining 50 percent is spread over 63 days. From these statistics, it is apparent that it is common to have two or three weeks of dry weather between showers. These dry spells can produce stress conditions for cultivated crops, native pastures, and meadows.

Most of the total annual precipitation comes from convective shower activity. Thunderstorms move across the county usually in the evening or at night. Rainfall is most common from 7 p.m. to 3 a.m. Forty percent of the hours that have rainfall during the 24 hour day occur between midnight and 6 a.m. Only 35 percent of the hours having rainfall occur during the peak outdoor work period of 6 a.m. to 6 p.m.

Snowfall in Stafford County is high in most years, averaging about 20 inches a year. Amounts are divided fairly even among the months of December through March. Maximum snowfall, however, tends to be late in winter. The most snow recorded in a calendar year at Hudson was 49.5 inches in 1960. Of that amount, 35 inches occurred in February and March. The greatest snow depth at any one time was 11 inches on December 12, 1928. In general, snow cover remains on the ground for periods of less than one week, but there are occasional exceptions. In 1960, there was snow on the ground (at least a trace) at Hudson from the last week in January until the middle of March. Blizzards occur at times during the snow season, especially early in spring. Such storms are usually of short duration.

[9]By L. DEAN BARK, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

TABLE 15.—*Temperature and precipitation data*

Month	Temperature[1]: Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have—: Maximum temperature higher than—	Minimum temperature lower than—	Average number of growing degree days[2]	Precipitation[1]: Average	2 years in 10 will have—: Less than—	More than—	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F		Inches	Inches	Inches		Inches
January	42.8	19.3	31.1	71	—9		0.55	0.09	0.76	1	3.8
February	48.2	24.0	36.1	79	—4		.92	.24	1.57	2	4.7
March	55.5	29.9	42.7	85	2	109	1.28	.27	2.01	3	4.4
April	69.0	42.6	55.8	92	22	329	2.29	1.12	3.29	4	.5
May	78.7	53.6	66.2	99	32	629	3.61	2.40	4.77	6	0
June	88.2	62.8	75.5	104	44	662	4.26	1.66	6.65	7	0
July	93.2	67.8	80.5	105	54	816	3.65	1.48	5.71	6	0
August	92.2	66.1	79.2	107	52	836	2.54	1.17	3.66	5	0
September	83.0	57.2	70.1	100	39	543	2.21	.70	3.73	4	0
October	71.9	45.9	58.9	93	25	253	2.09	.39	3.67	3	.4
November	56.0	32.0	44.0	78	5		.79	.05	1.74	2	1.4
December	44.4	23.9	34.2	70	—4		.87	.19	1.51	2	4.6
Year	68.8	43.8	56.4	107	—10	4,175	25.04	19.25	30.99	44	20.5

[1]Recorded in the period 1941-1970 at Hudson, Kansas.
[2]Based on Larned temperatures 1941-70. Calculated by the National Weather Service 50-86 method.

Temperature ranges are large in a continental climate. Annual extremes are generally –5° to –10° F and about 105° F. The lowest temperature recorded at Hudson was –20° on February 1, 1951. Temperature records were not taken in the county during the 1930's, but Larned reported 114° on three separate days during July and August in 1936.

The average temperature data in table 15 indicates the rather short transition seasons of spring and fall in Kansas. Winter weather exists from December through February, and the average daily temperature during that period is in the 30's or lower. Summer conditions and warm temperatures necessary for plant growth continue from late in April to early in October.

The average growing season, or the period between the last 32° freeze in spring and the first in fall, is 185 days in Stafford County. There is little crop damage as a result of freezing weather in most years. Freezes late in spring occasionally damage winter wheat. The probability of freezes of differing severity in spring and fall are given in table 16 (*3*).

The prevailing wind direction is southerly, but northerly winds are not uncommon, particularly in winter. Average wind velocities, which are moderately strong in all seasons, reach a maximum speed in spring. Average hourly velocity in the windiest month, March, is about 14 miles per hour.

Although climatic conditions in Stafford County are generally favorable for successful crop production, crop yields on nonirrigated farms are often reduced by a lack of soil moisture. The combination of high temperatures, dry weather, strong winds, and low humidities produce a high demand of moisture and cause greatest crop damage. During such periods, evapotranspiration rates are high and cultivated crops are unable to maintain satisfactory growth. If the plant cover is limited, conditions are ideal for soil blowing. During the period 1931-68, droughts classified as mild, moderate, severe, or extreme were recorded during 191 months (*5*). There were severe or extreme periods of drought in 83 months, or about 20 percent of the period studied. These figures are probably higher than average because the period of study includes the devastating droughts of the 30's and 50's. A longer period of study would undoubtedly show a reduction in the percentage of time in which severe and extreme drought conditions exist. The reduction

TABLE 16.—*Freeze dates in spring and in fall*

Probability	Minimum temperature[1]: 24°F or lower	28°F or lower	32°F or lower
Last freezing temperature in spring:			
1 year in 10 later than	Apr. 12	Apr. 23	May 5
2 years in 10 later than	Apr. 7	Apr. 18	Apr. 30
5 years in 10 later than	Mar. 29	Apr. 8	Apr. 20
First freezing temperature in fall:			
1 year in 10 earlier than	Oct. 27	Oct. 16	Oct. 8
2 years in 10 earlier than	Nov. 1	Oct. 24	Oct. 12
5 years in 10 earlier than	Nov. 10	Nov. 2	Oct. 22

[1]From Bulletin 415, Kansas State Agricultural Experiment Station.

would not be appreciable, and agricultural operations in this section of Kansas need to be aware of the high potential of drought.

Occasionally tornadoes and severe wind storms occur in Stafford County. These storms are associated with the passage of squall lines through the state. Stafford County is somewhat close to the center of maximum tornadoes in east-central Oklahoma, and the major threat is in June. When these storms do occur, they are local in extent and are of short duration so that risk is small. The county is farther from the center of maximum occurrence of hail storms (NE-Colorado, SE-Wyoming, Nebraska panhandle). Hail is associated with heavy rains, and thus the months of May and June are the months of most frequent hail.

Transportation

Stafford County is served by the Atchison, Topeka, and Santa Fe Railroad which passes through Zenith, Stafford, St. John, Dillwyn, and Macksville. A branch line of the Missouri Pacific serves Neola, Stafford, Bedford, Hudson, and Seward and ends one-half mile west of Radium. U.S. Highway 281 crosses the county north to south near St. John. U.S. Highway 50 crosses it from east to west through Zenith, Stafford, and Macksville. Kansas Highway 19 crosses the northwest part of the county east to west, from U.S. Highway 281 to a mile south of Seward and Radium. A network of good roads serve the rest of the county except in hilly, sandy areas and in some places along Rattlesnake Creek and the North Fork of the Ninnescah River.

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Glossary

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or has hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Chlorosis. Yellowing or blanching of green portions of a plant, particularly the leaves. May be caused by disease organisms, unavailability of nutrients, or other factors.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike

that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft. When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Depth classes, soil. The upper limit and the lower limit of a depth class, applied to any one soil, are fixed in definite figures. These limits need to vary somewhat among soils depending on the other soil characteristics. In this survey, the approximate upper and lower limits of depth classes are as follows:

	Inches
Very shallow	0 to 10
Shallow	10 to 20
Moderately deep	20 to 40
Deep	more than 40

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonyms: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The mineral of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Leaching. The removal of soluble material from soil or other material by percolating water.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the mineral in these horizons are unlike those of the underlying materal. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained(each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

(For a complete description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs)

Map Symbol	Mapping unit	Page	Capability Unit Symbol: Dryland	Capability Unit Symbol: Irrigated	Range site: Name	Range site: Page
An	Albion sandy loam, 1 to 4 percent-----------	9	IIIe-3	IIIe-3	Sandy	27
At	Attica fine sandy loam, 1 to 4 percent slopes	9	IIe-2	IIe-2	Sandy	27
Ba	Blanket silt loam---------------------------	10	IIc-1	I	Loamy Upland	27
Ca	Carwile fine sandy loam---------------------	11	IIw-1	IIw-1	Sandy	27
Cw	Carwile complex-----------------------------	11	IVs-2	IVs-2	Sandy	27
Cx	Clark loam, 1 to 3 percent slopes-----------	11	IIIe-2	IIIe-2	Limy Upland	26
Dp	Dillwyn-Plevna complex----------------------	12	Vw-2	------	Subirrigated	28
Dt	Dillwyn-Tivoli loamy fine sands, 0 to 15 percent slopes----------------------------	12	VIe-2	------	------------------	--
	Dillwyn series--------------------------	--	------	------	Subirrigated	28
	Tivoli series---------------------------	--	------	------	Sands	27
Fa	Farnum fine sandy loam----------------------	13	IIe-1	IIe-1	Sandy	27
Fr	Farnum loam---------------------------------	13	IIc-1	I	Loamy Upland	27
Kg	Kingman silty clay loam---------------------	14	Vw-3	------	Subirrigated	28
Na	Naron fine sandy loam-----------------------	14	IIe-1	IIe-1	Sandy	27
Nu	Natrustolls---------------------------------	14	VIs-1	------	Saline Subirrigated	27
Pa	Plevna soils--------------------------------	16	Vw-1	------	Subirrigated	28
Pc	Plevna soils, channeled---------------------	16	VIw-1	------	Subirrigated	28
Ph	Pratt loamy fine sand, hummocky-------------	16	IVe-1	IIIe-1	Sands	27
Po	Pratt loamy fine sand, undulating-----------	16	IIIe-1	IIIe-1	Sands	27
Pr	Pratt-Carwile complex, 0 to 8 percent slopes-	17	IIIe-1	IIIe-1	-------------------	--
	Pratt series----------------------------	--	------	------	Sands	27
	Carwile series--------------------------	--	------	------	Sandy	27
Pt	Pratt-Tivoli loamy fine sands, hummocky------	17	VIe-1	IVe-1	Sands	27
Ta	Tabler loam---------------------------------	17	IIs-1	IIs-1	Clay Upland	26
Tv	Tivoli fine sand, hilly---------------------	18	VIIe-1	------	Choppy Sands	26
Wa	Waldeck fine sandy loam---------------------	18	IIIw-1	IIIw-1	Subirrigated	28
Za	Zenda-Natrustolls complex-------------------	19	IVs-1	IVs-1	-------------------	--
	Zenda series----------------------------	--	-------	------	Subirrigated	28
	Natrustolls-----------------------------	--	------	------	Saline Subirrigated	27

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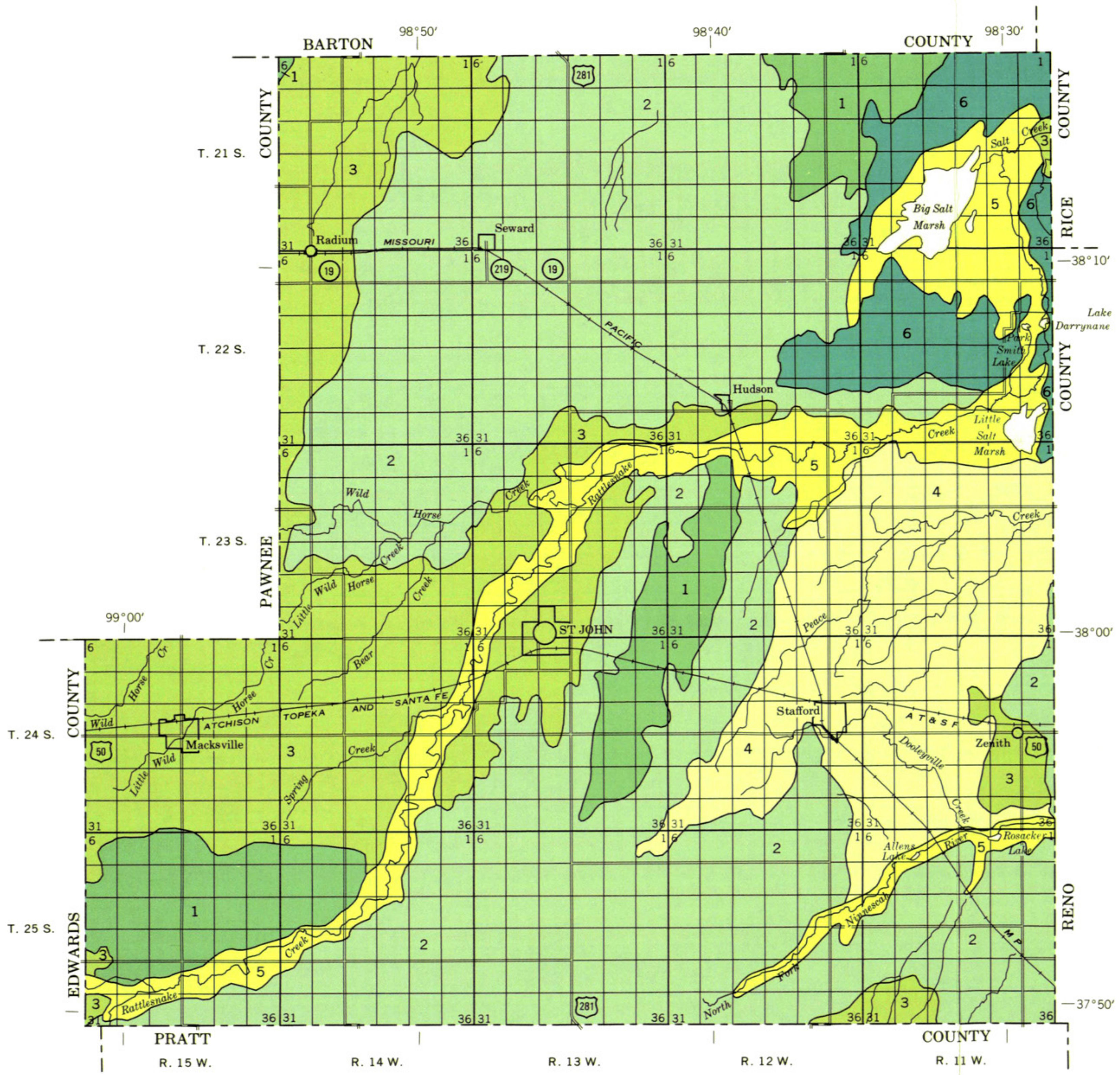


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

STAFFORD COUNTY, KANSAS

Scale 1:253,440

1 0 1 2 3 4 Miles

SOIL ASSOCIATIONS *

1 Pratt-Tivoli association: Undulating to hilly sandy soils; on uplands

2 Pratt-Carwile association: Undulating to rolling sandy soils, and nearly level loamy soils; on uplands

3 Naron-Farnum association: Nearly level and gently sloping loamy soils; on uplands

4 Blanket-Farnum association: Nearly level loamy soils; on uplands

5 Natrustolls-Plevna association: Nearly level, salt-affected loamy soils, and loamy soils with a seasonally high water table; on flood plains

6 Dillwyn-Tivoli association: Nearly level to gently rolling, wet sandy soils and undulating to hilly sandy soils; on uplands

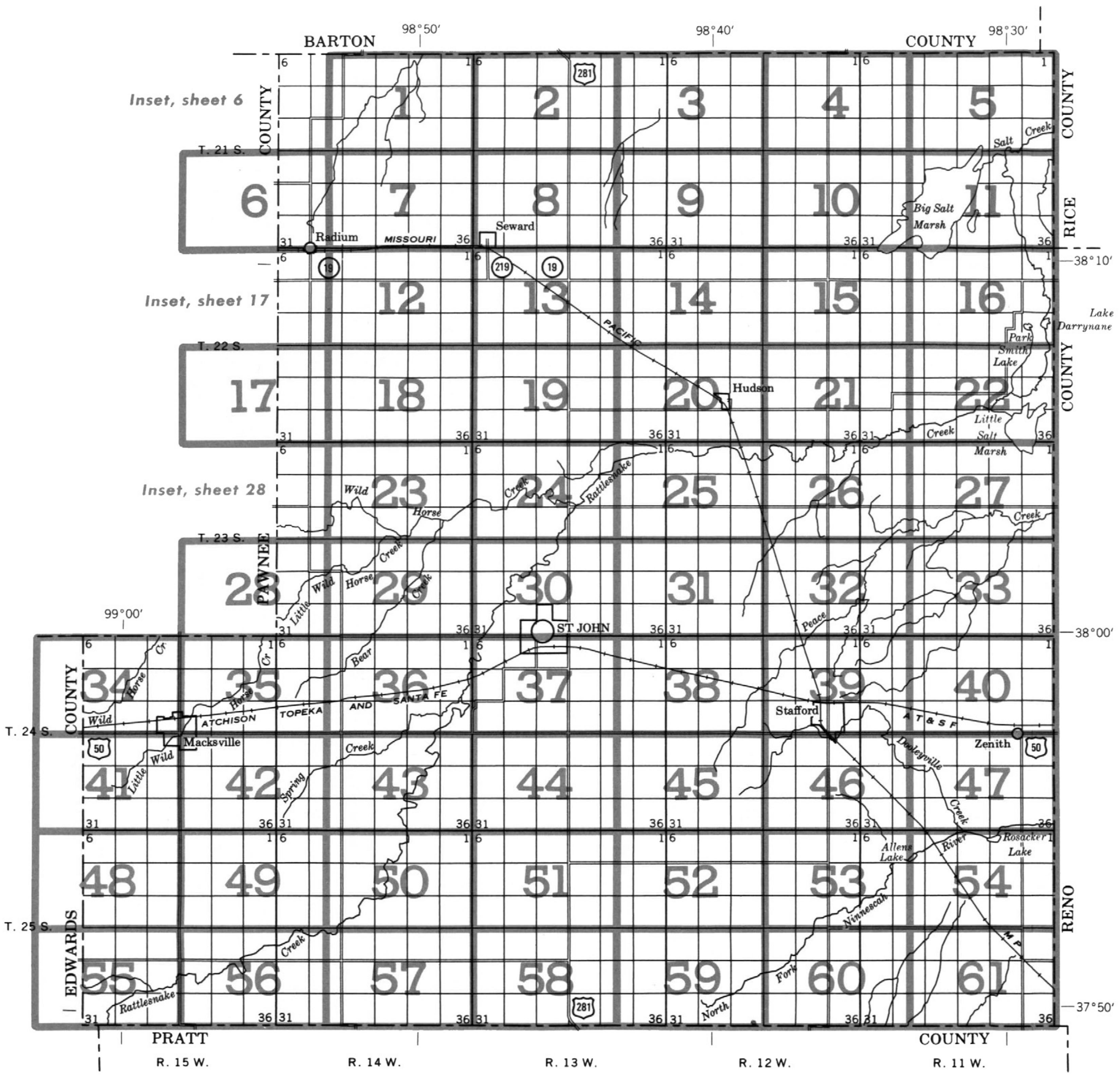
* Terms for texture apply to the surface layer of the major soils

Compiled 1977

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

STAFFORD COUNTY, KANSAS

Scale 1:253,440

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
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SOIL LEGEND

SYMBOL	NAME
An	Albion sandy loam, 1 to 4 percent slopes
At	Attica fine sandy loam, 1 to 4 percent slopes
Ba	Blanket silt loam
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Ta	Tabler loam
Tv	Tivoli fine sand, hilly
Wa	Waldeck fine sandy loam
Za	Zenda-Natrustolls complex

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CeA; FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

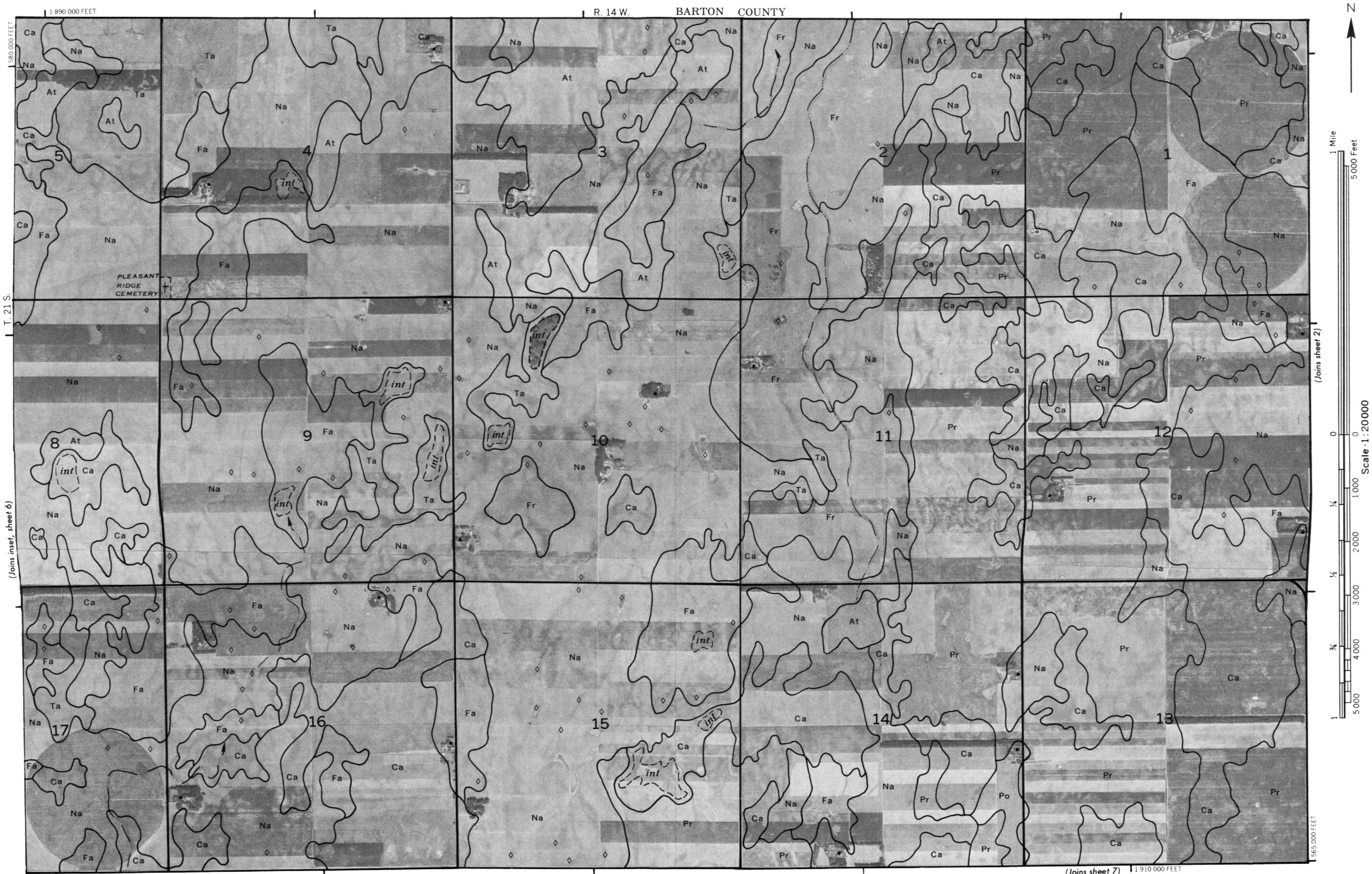
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

1



STAFFORD COUNTY, KANSAS NO. 1

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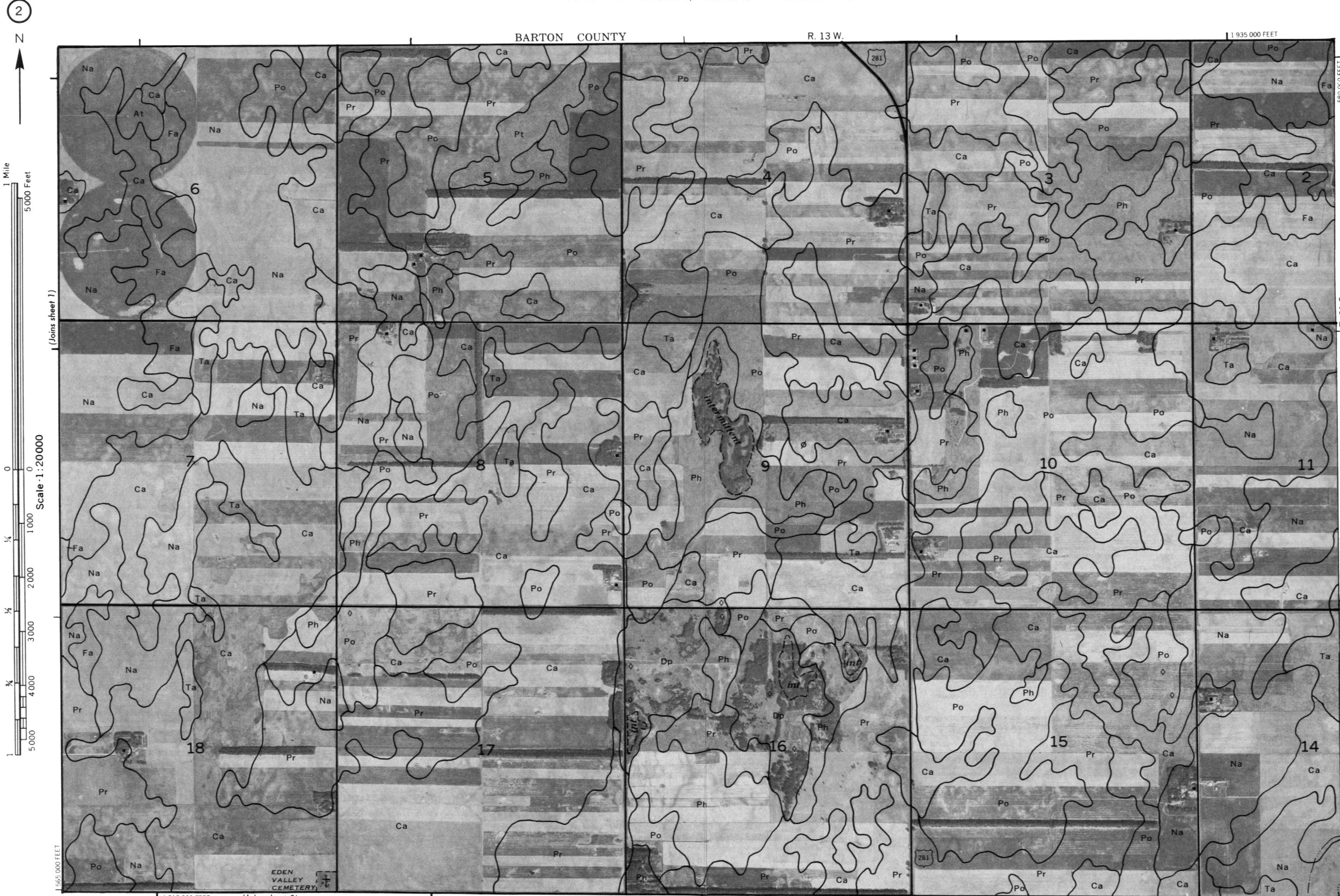
STAFFORD COUNTY, KANSAS — SHEET NUMBER 2



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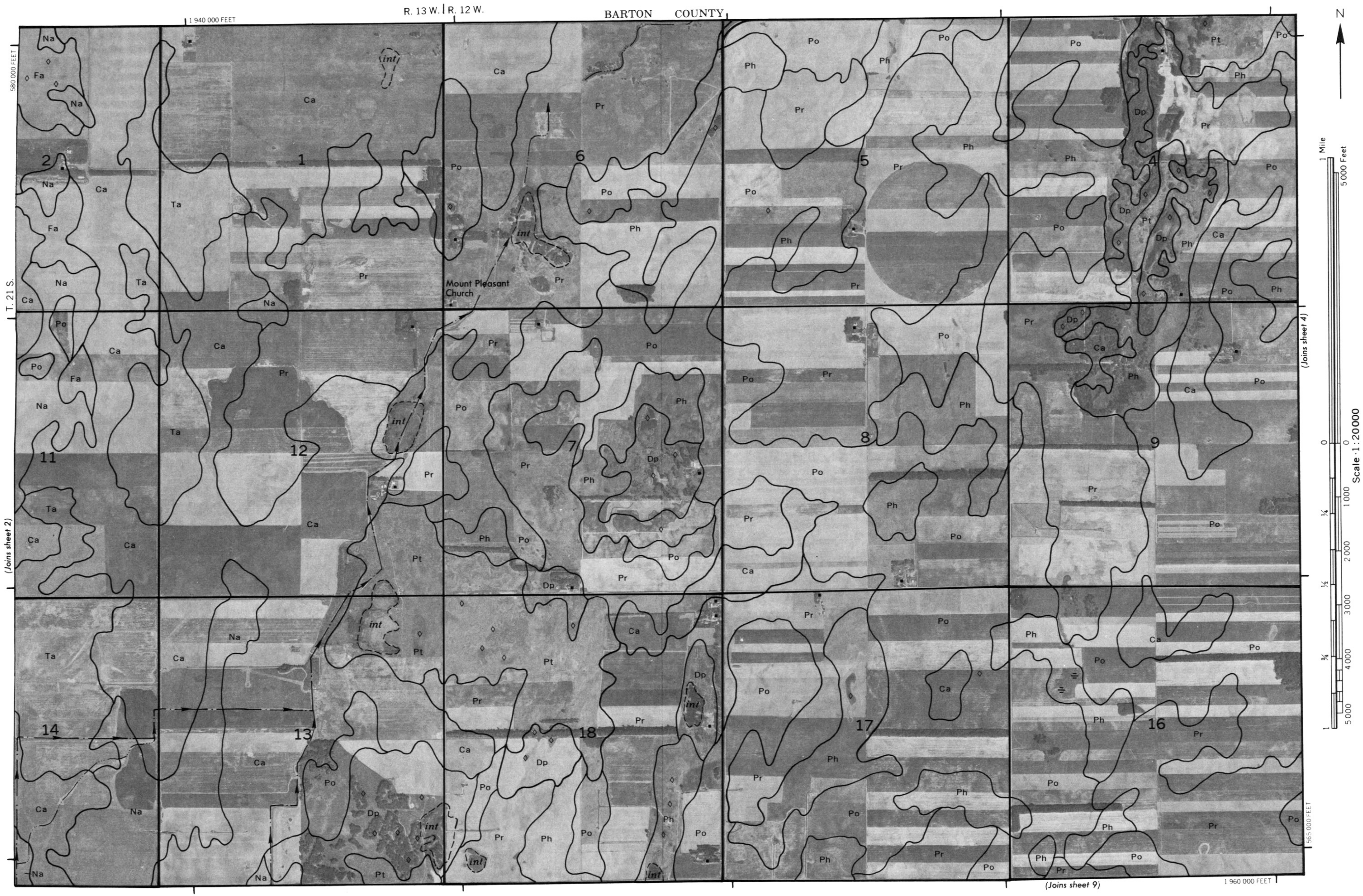

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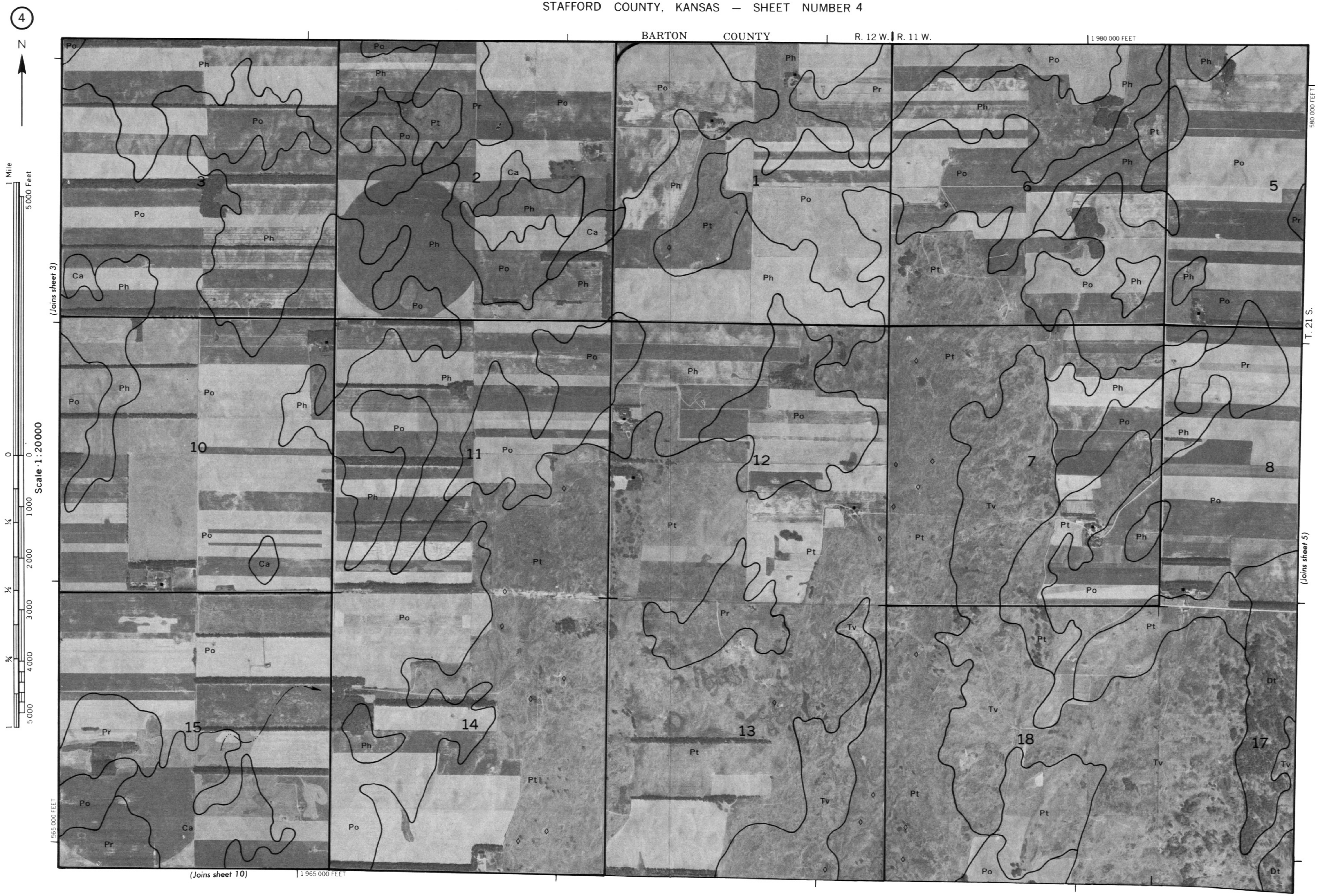

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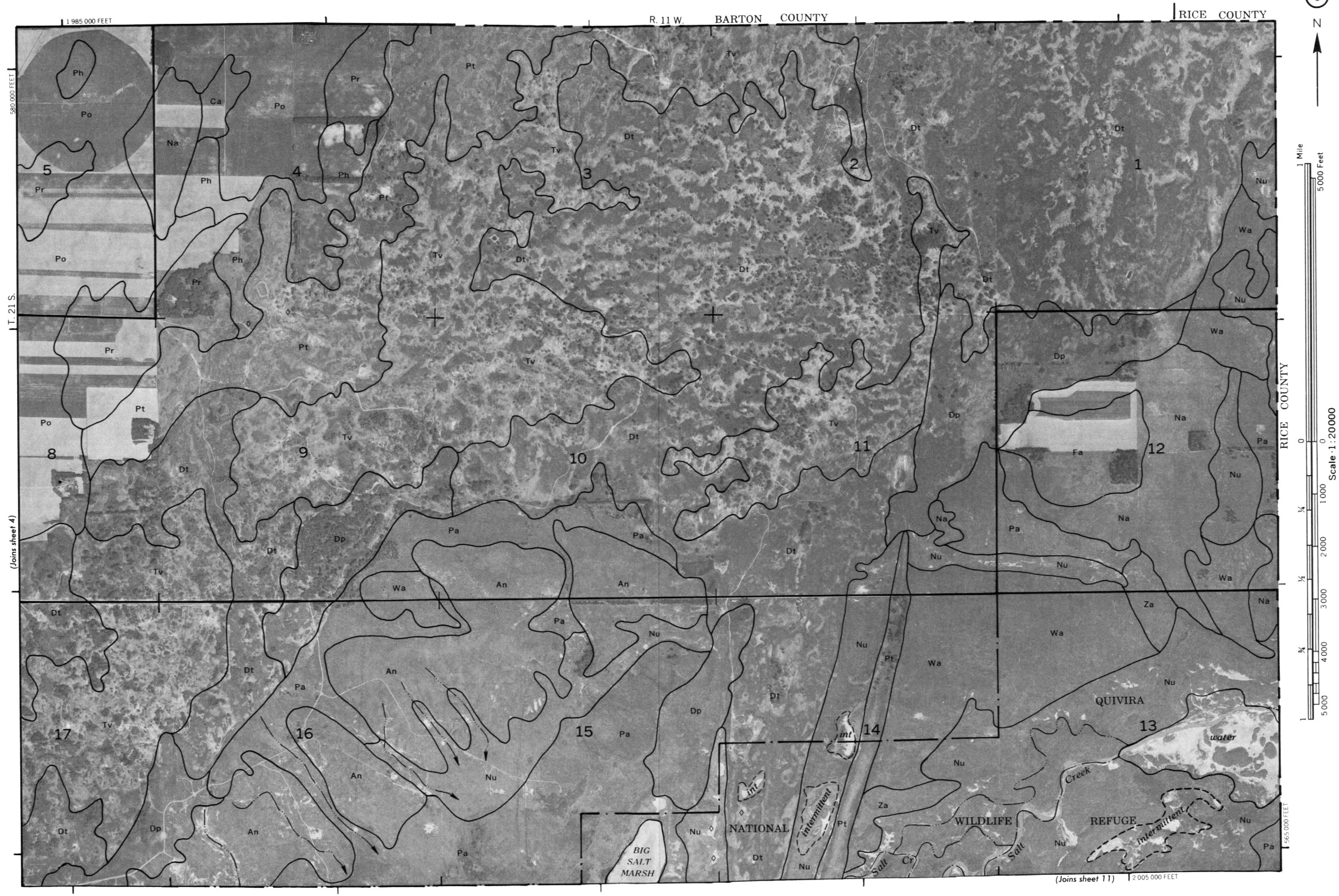

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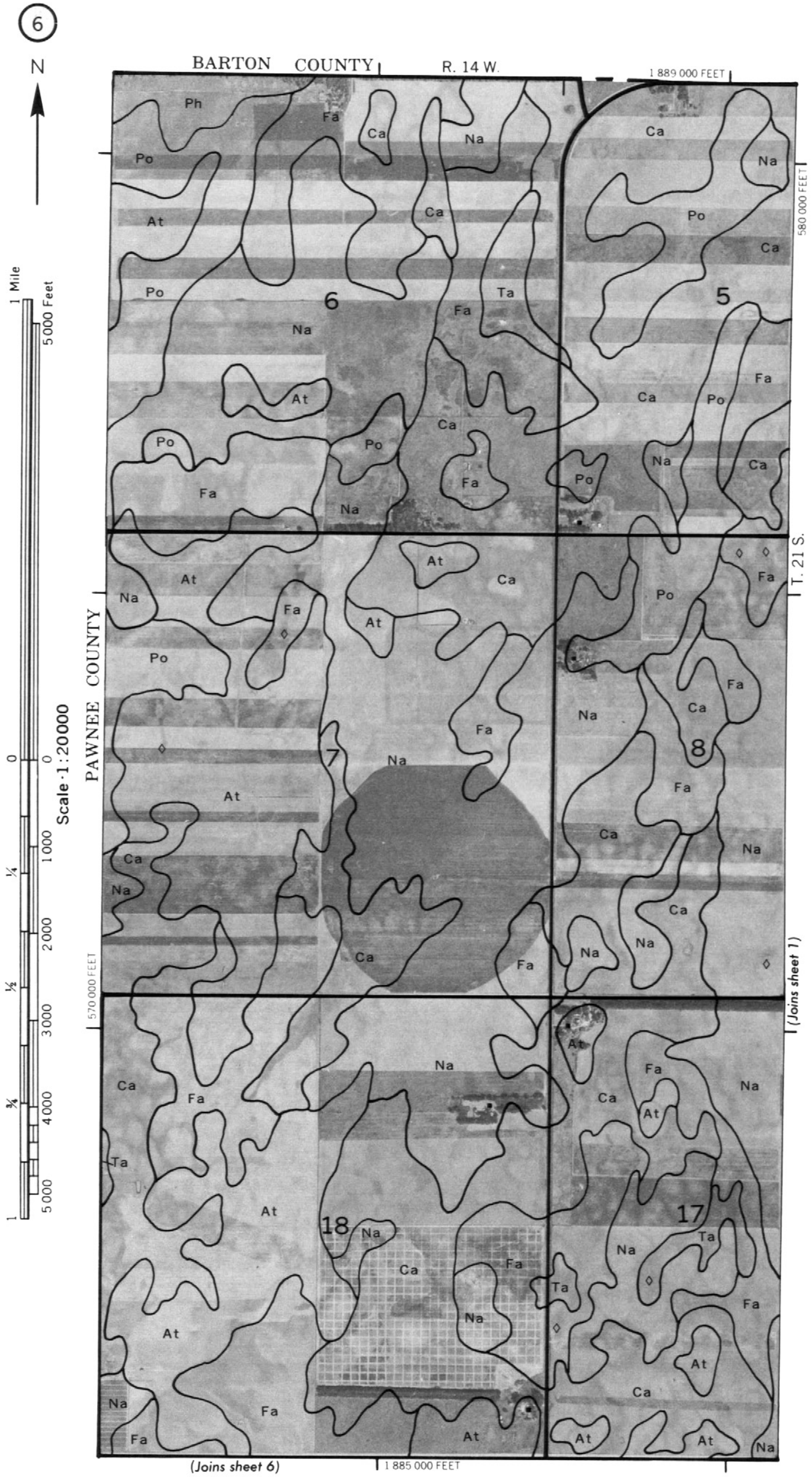

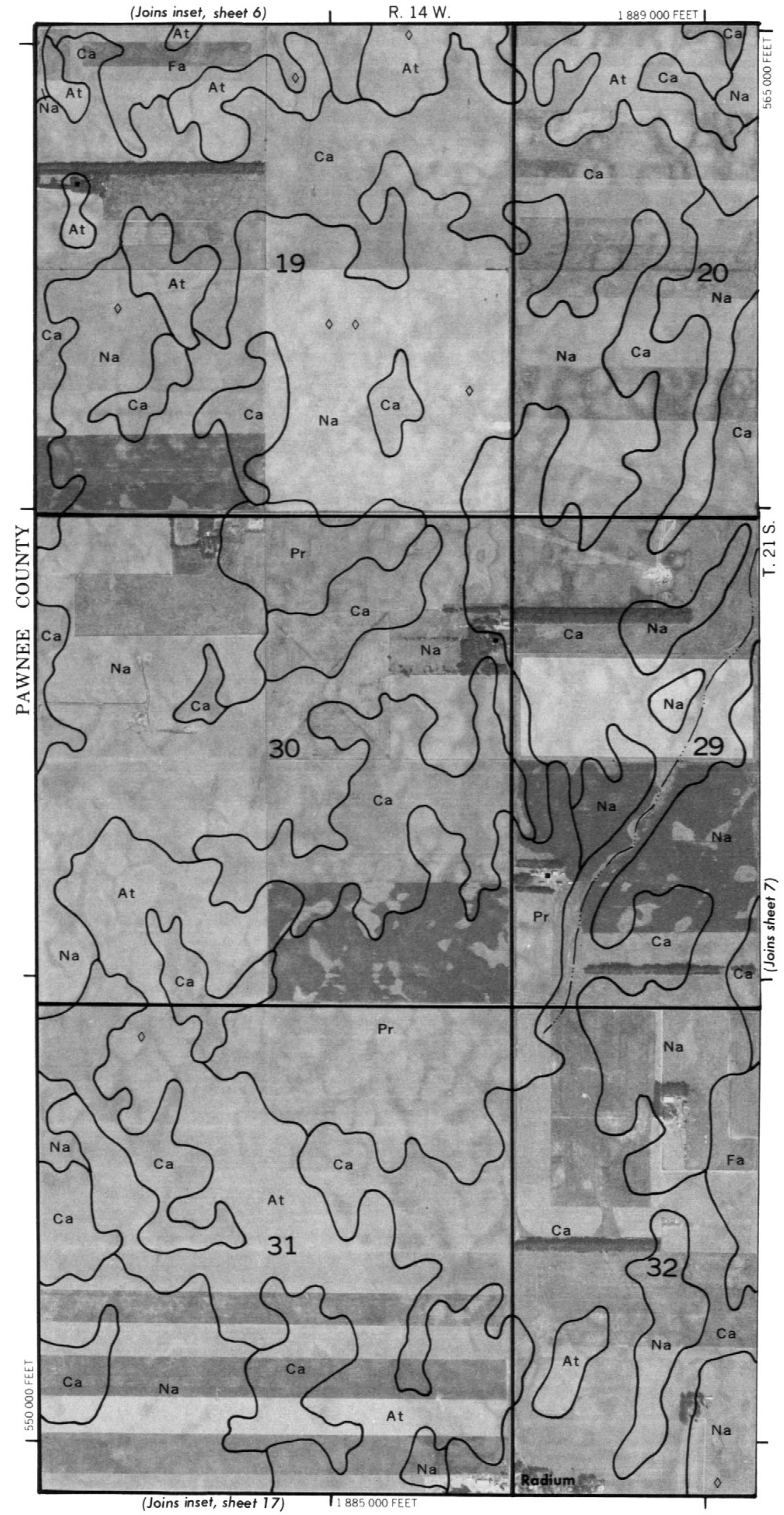

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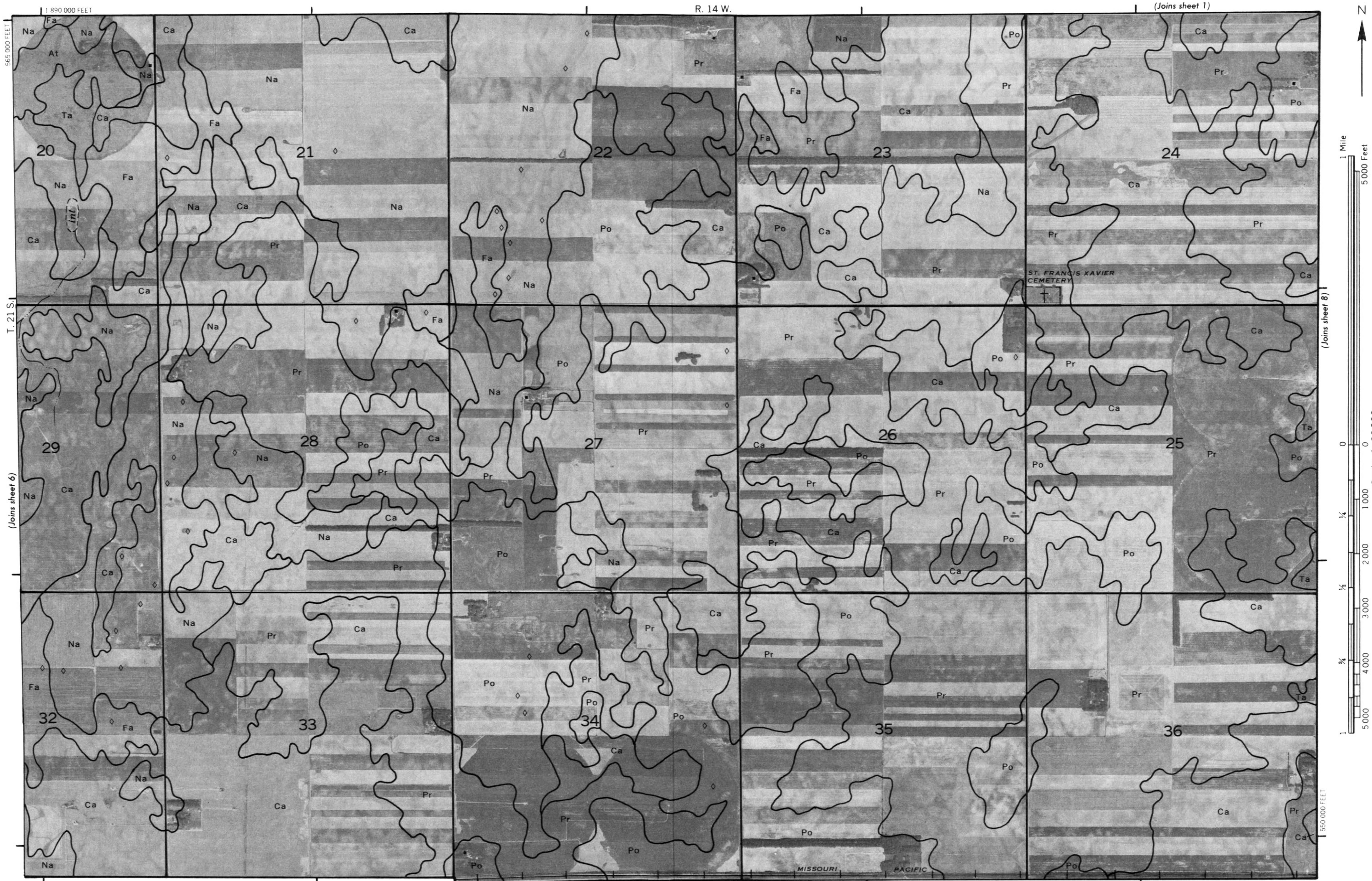

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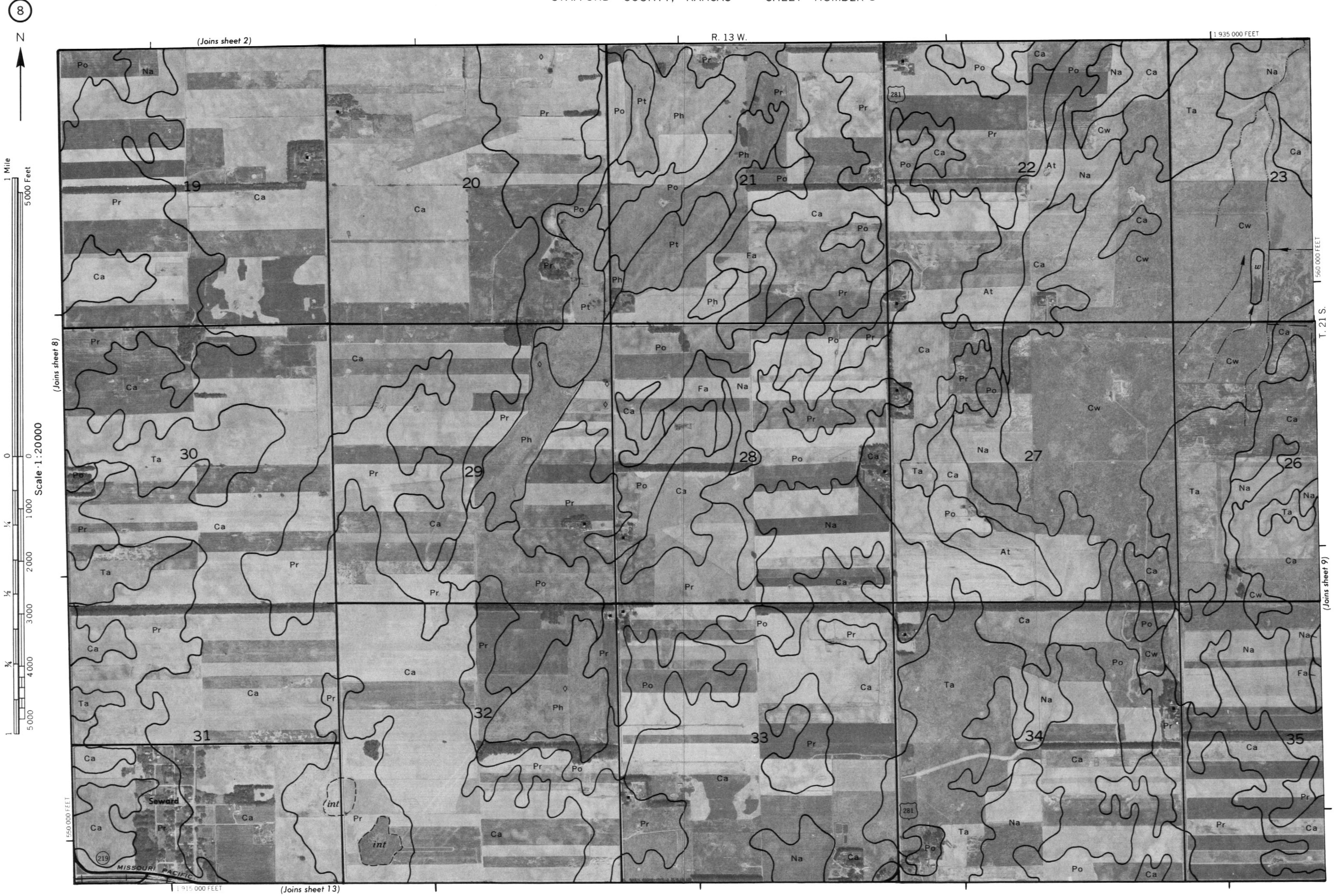

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STAFFORD COUNTY, KANSAS NO. 8

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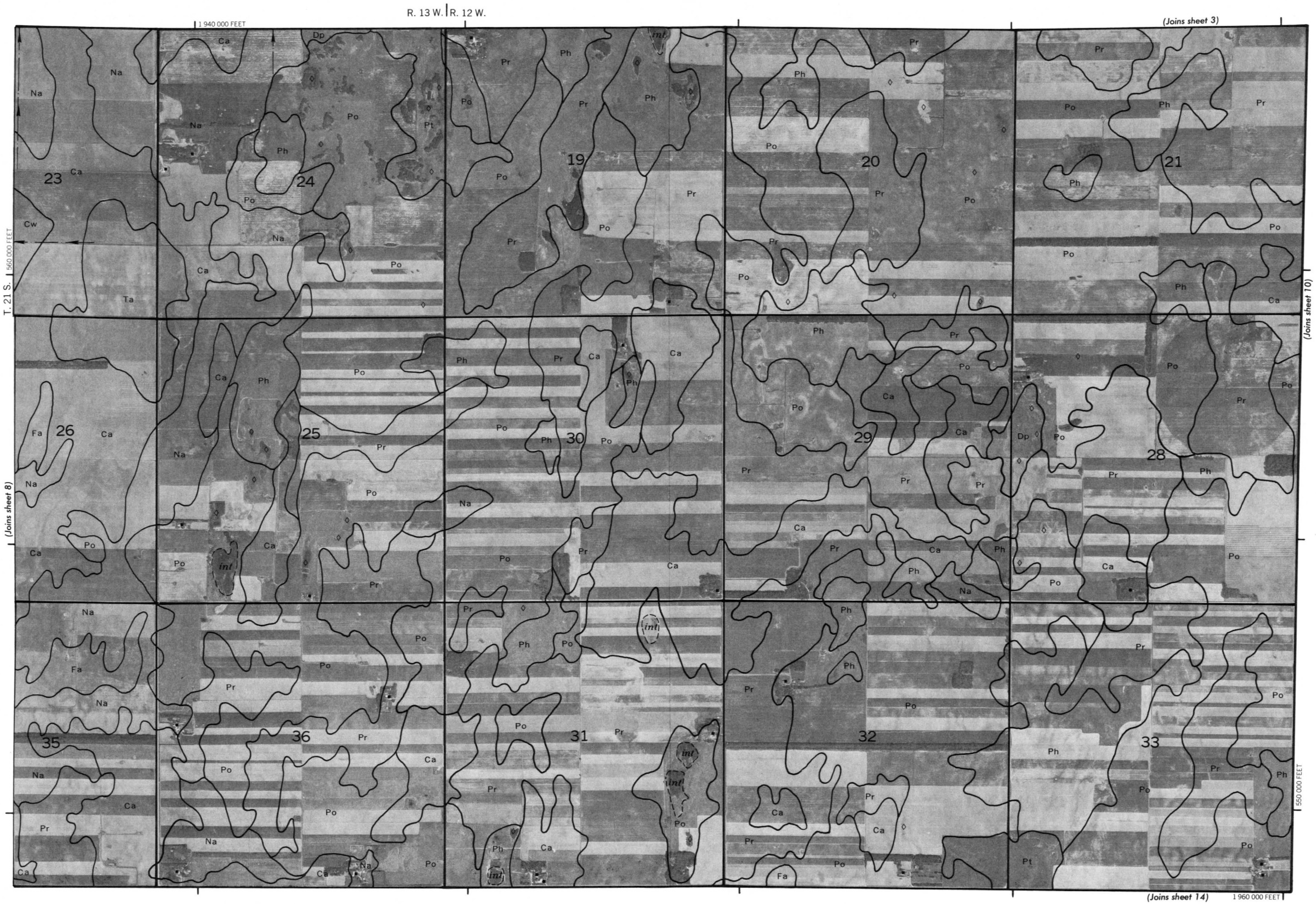

1 Mile
5000 Feet
0
1000
¼
2000
½
3000
¾
4000
5000
1
Scale 1:20000

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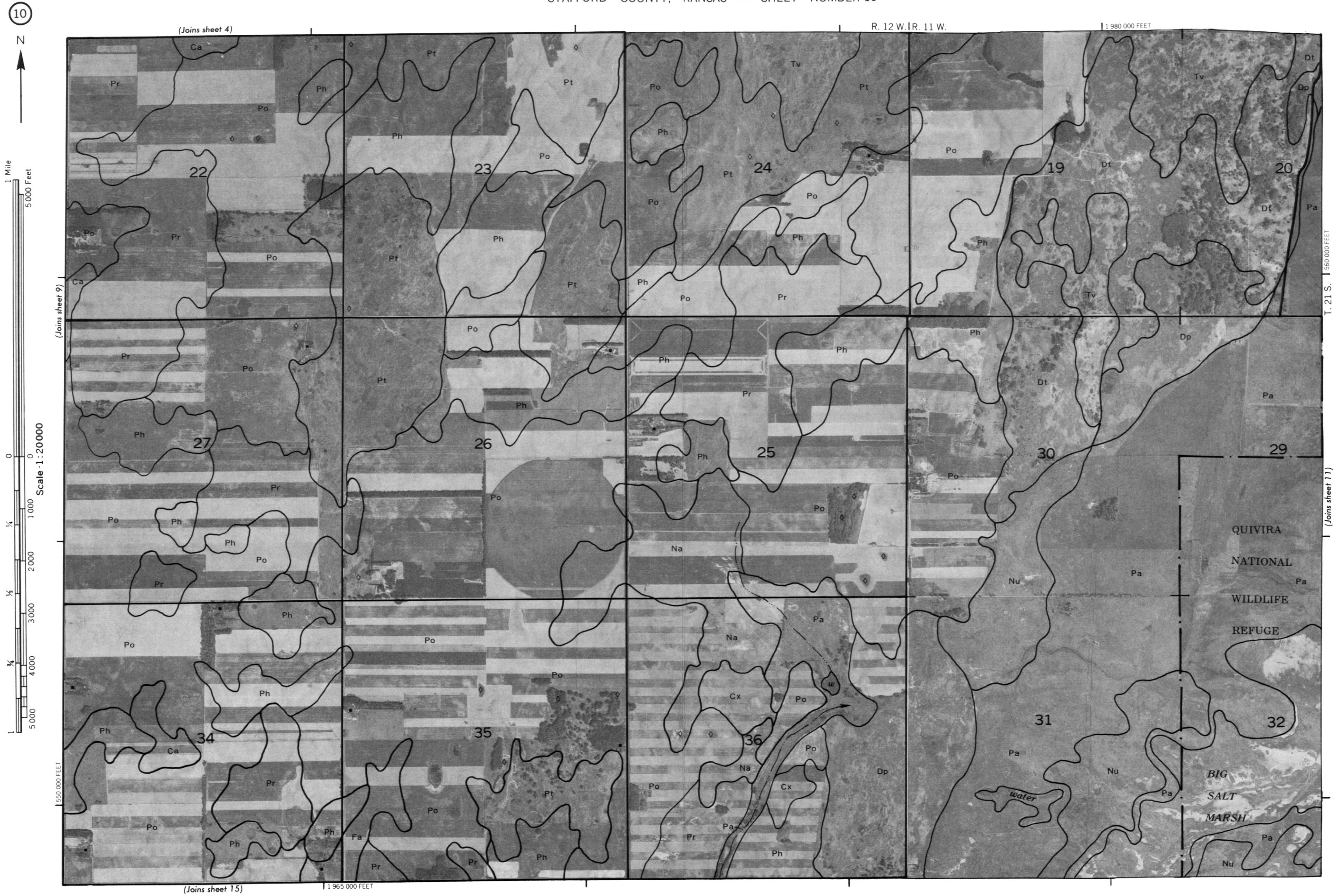

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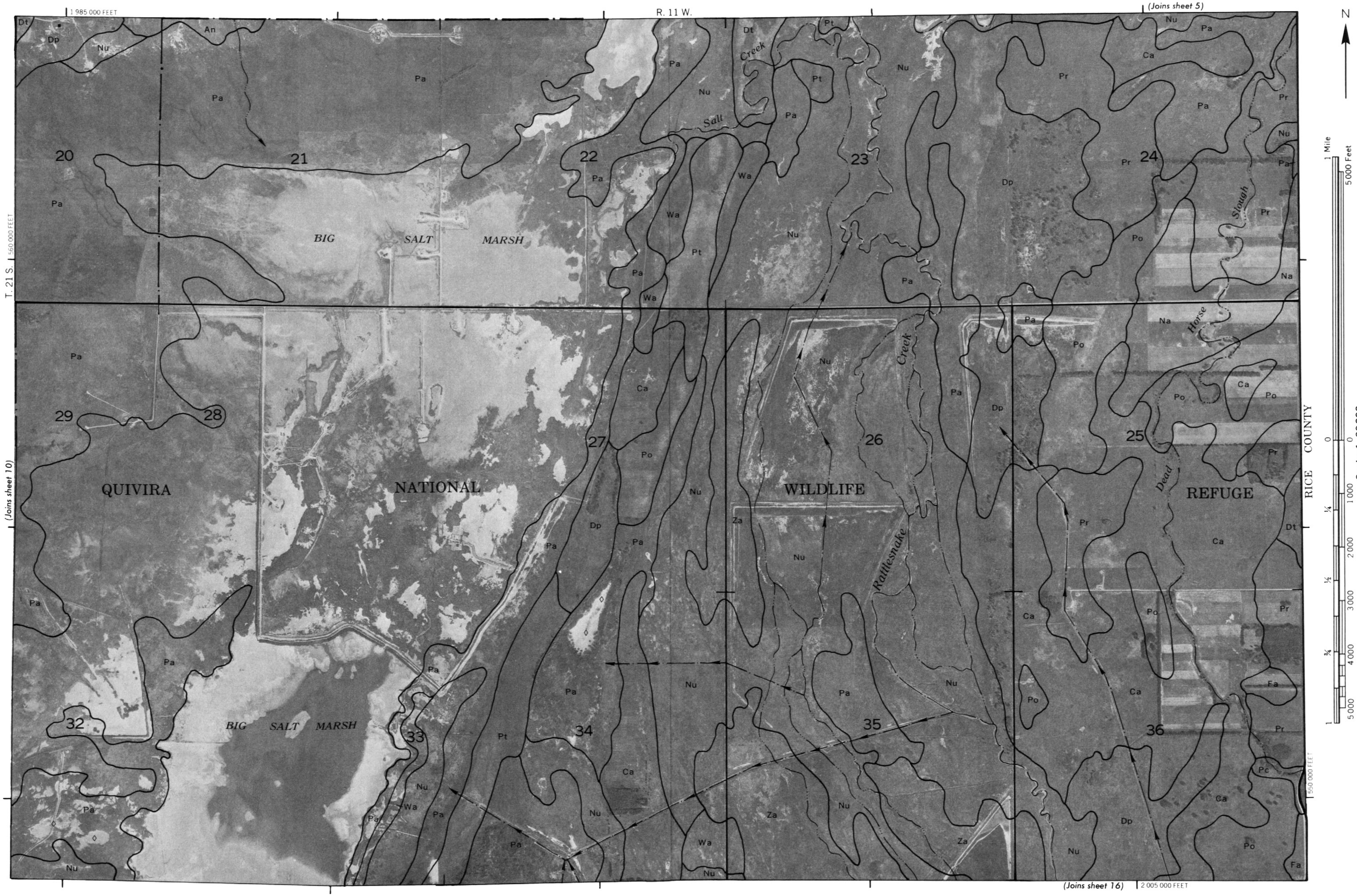

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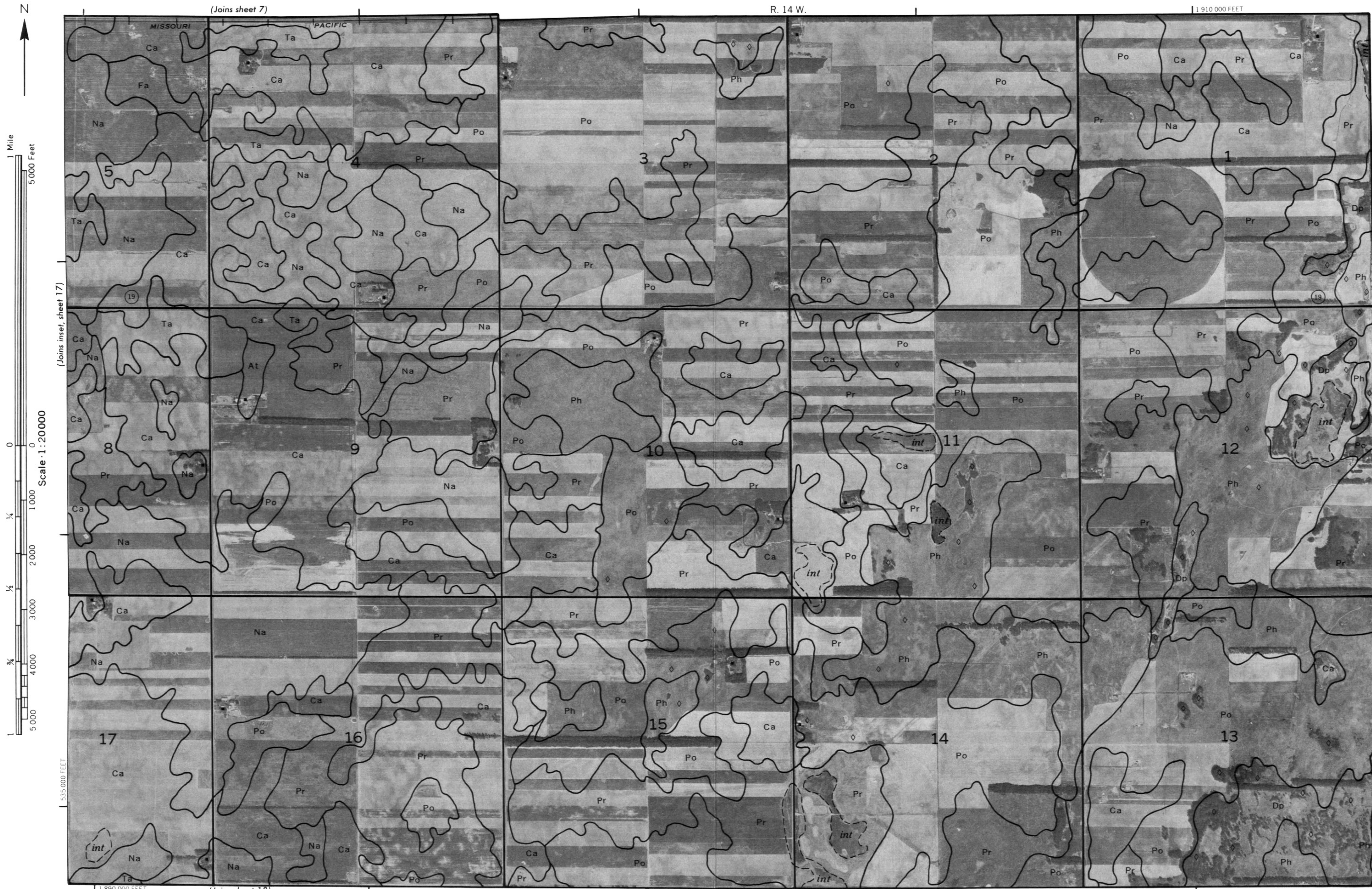

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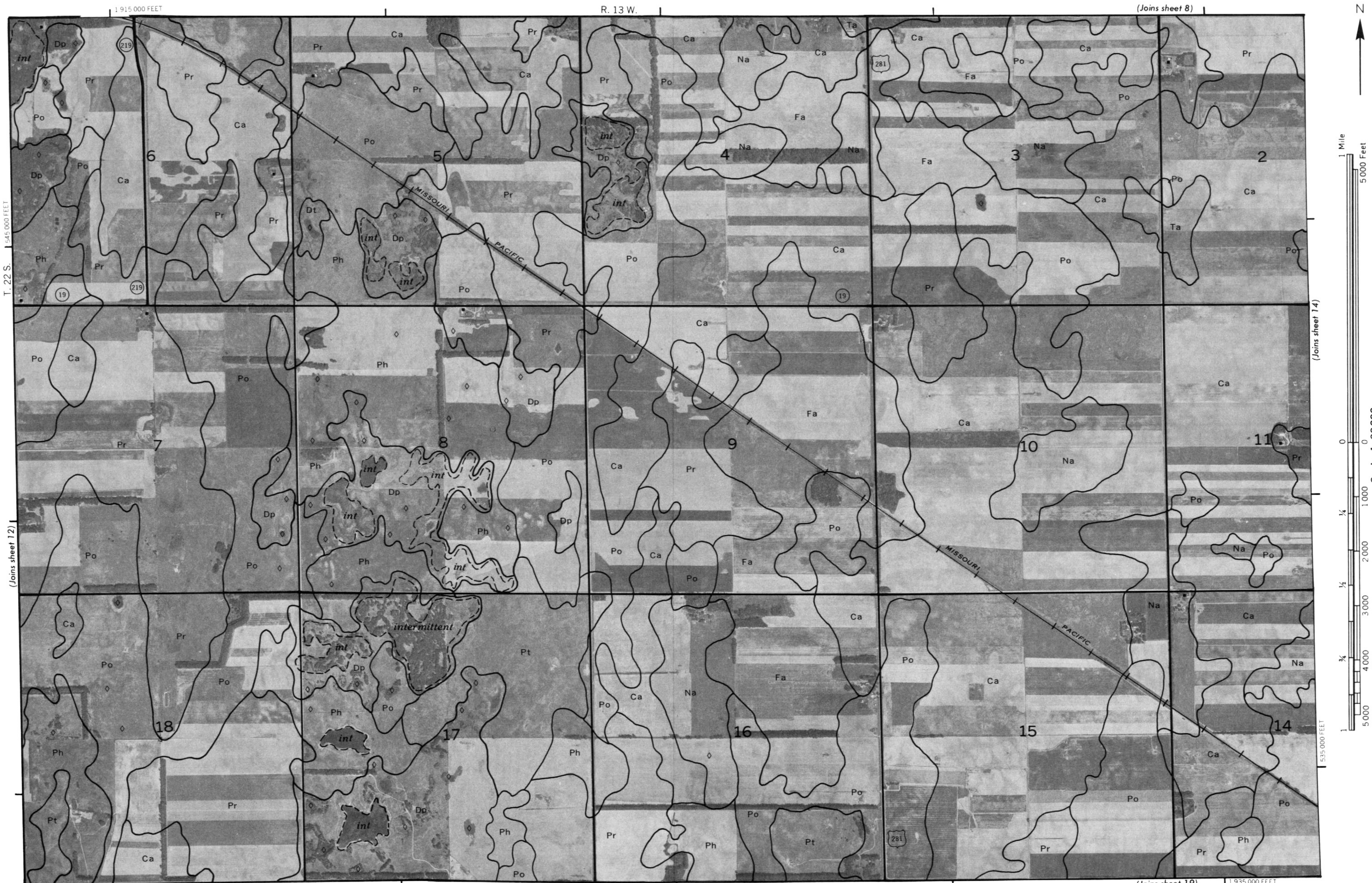

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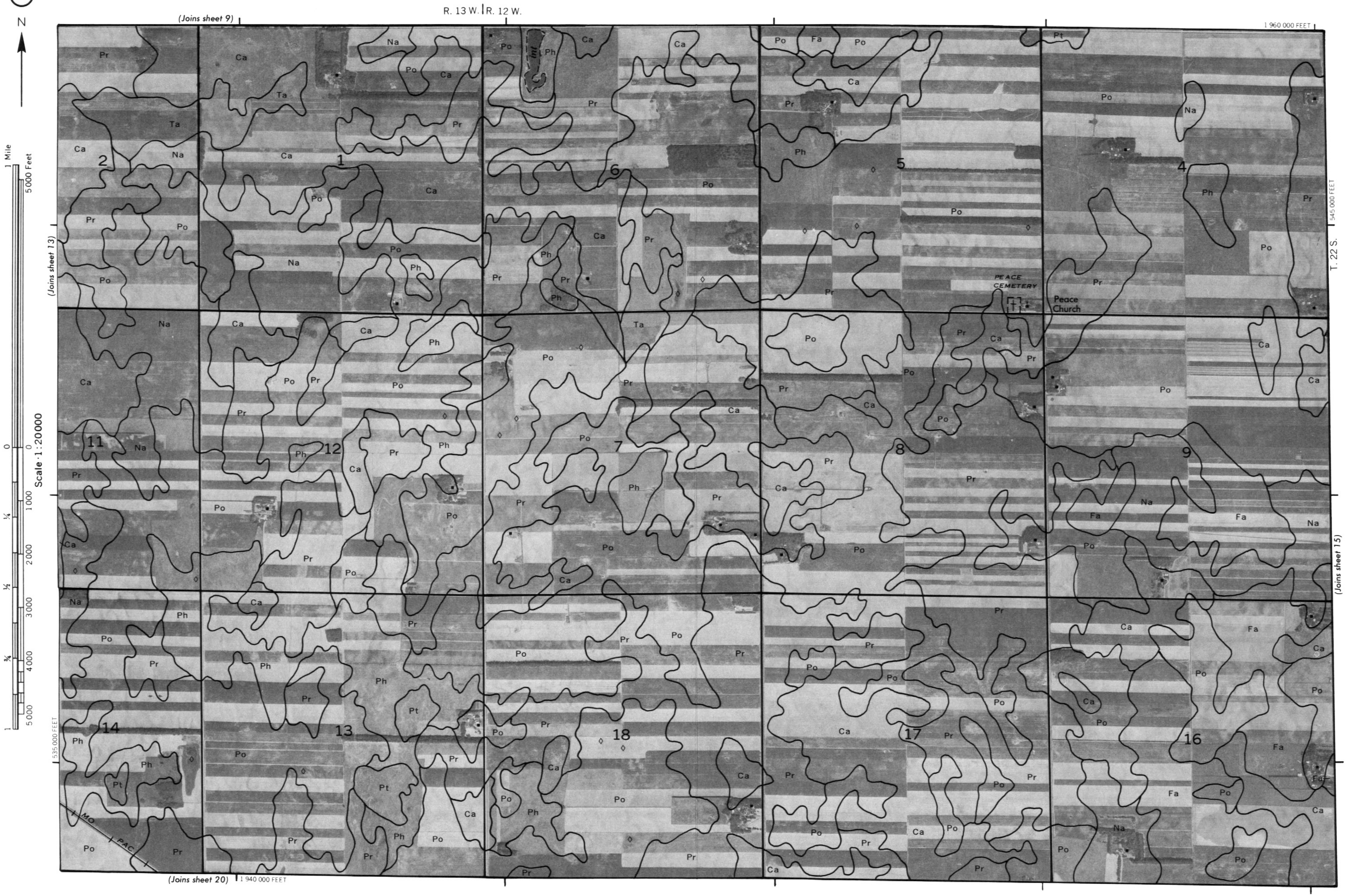
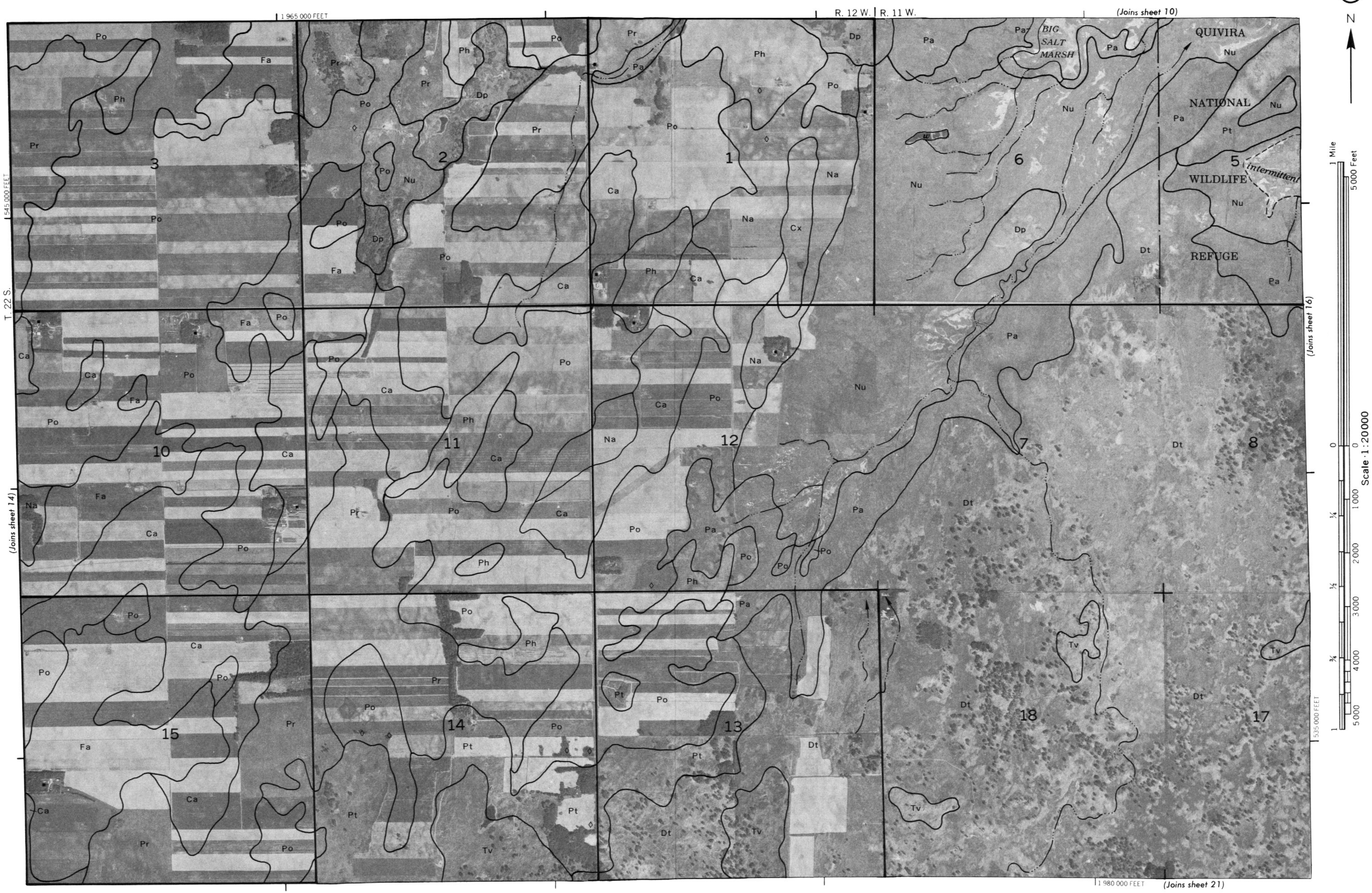
STAFFORD COUNTY, KANSAS — SHEET NUMBER 14



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

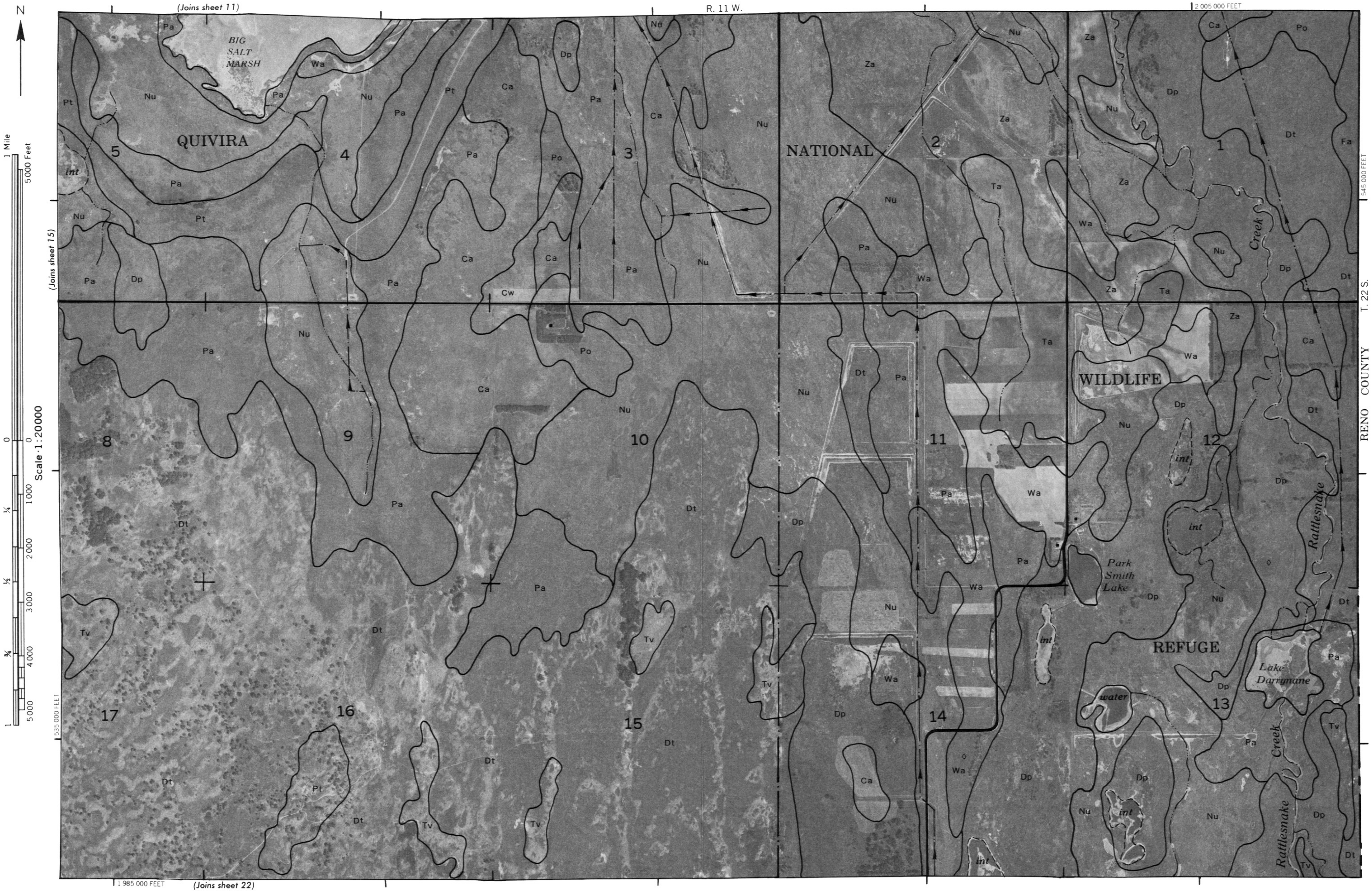
STAFFORD COUNTY, KANSAS NO. 14



STAFFORD COUNTY, KANSAS NO. 15

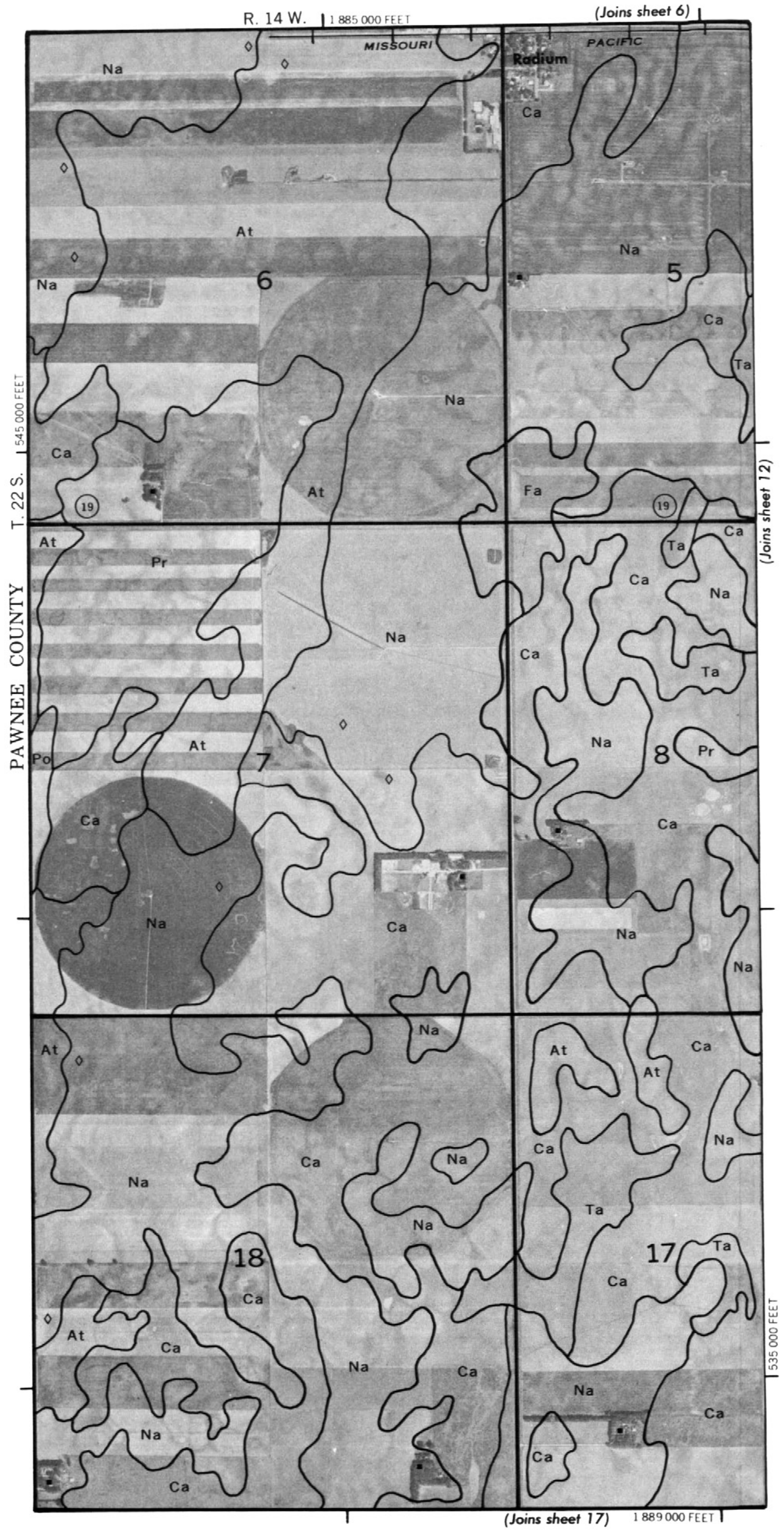
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 16

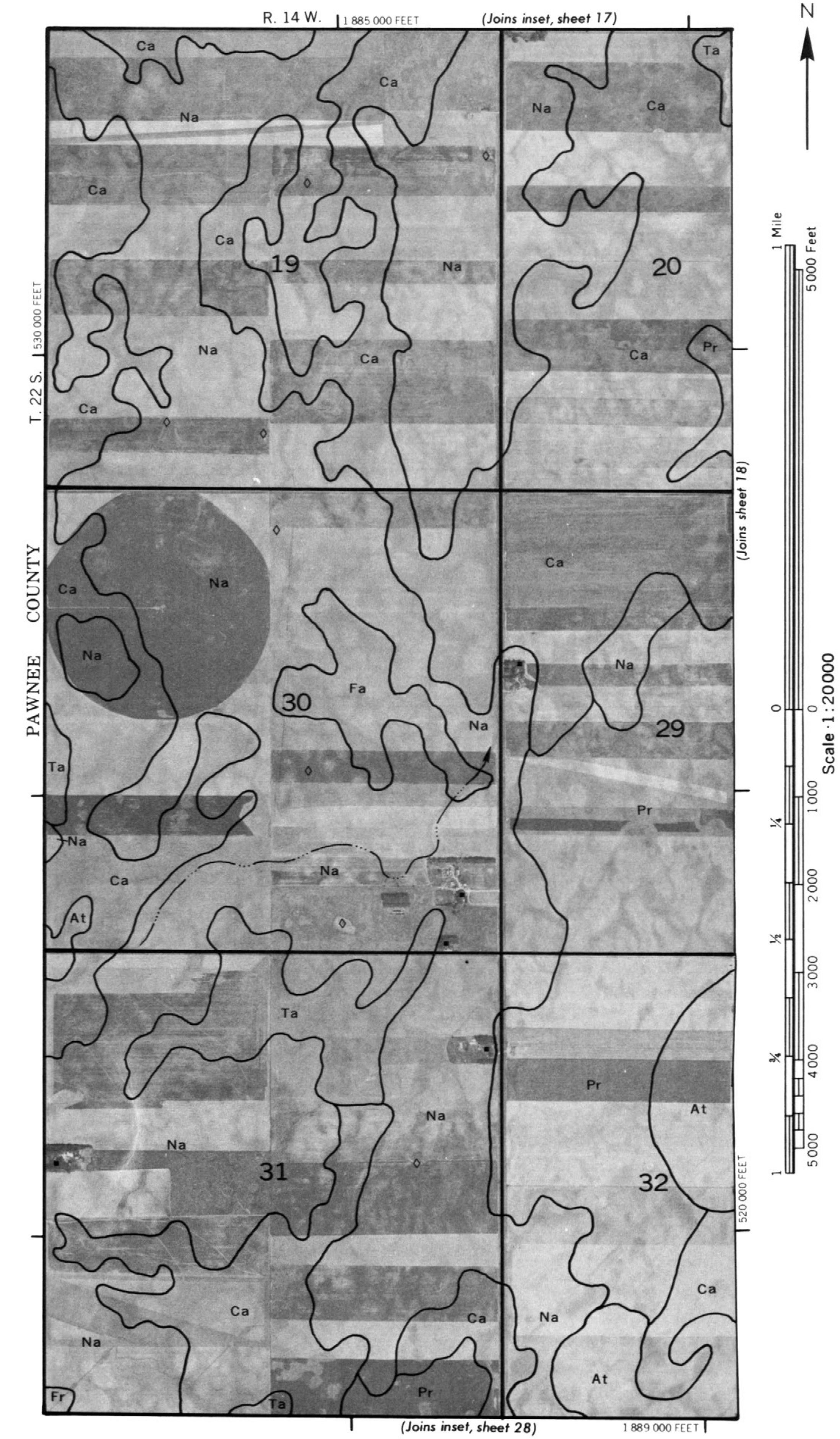


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS NO. 16



4000 AND 5000-FOOT GRID TICKS

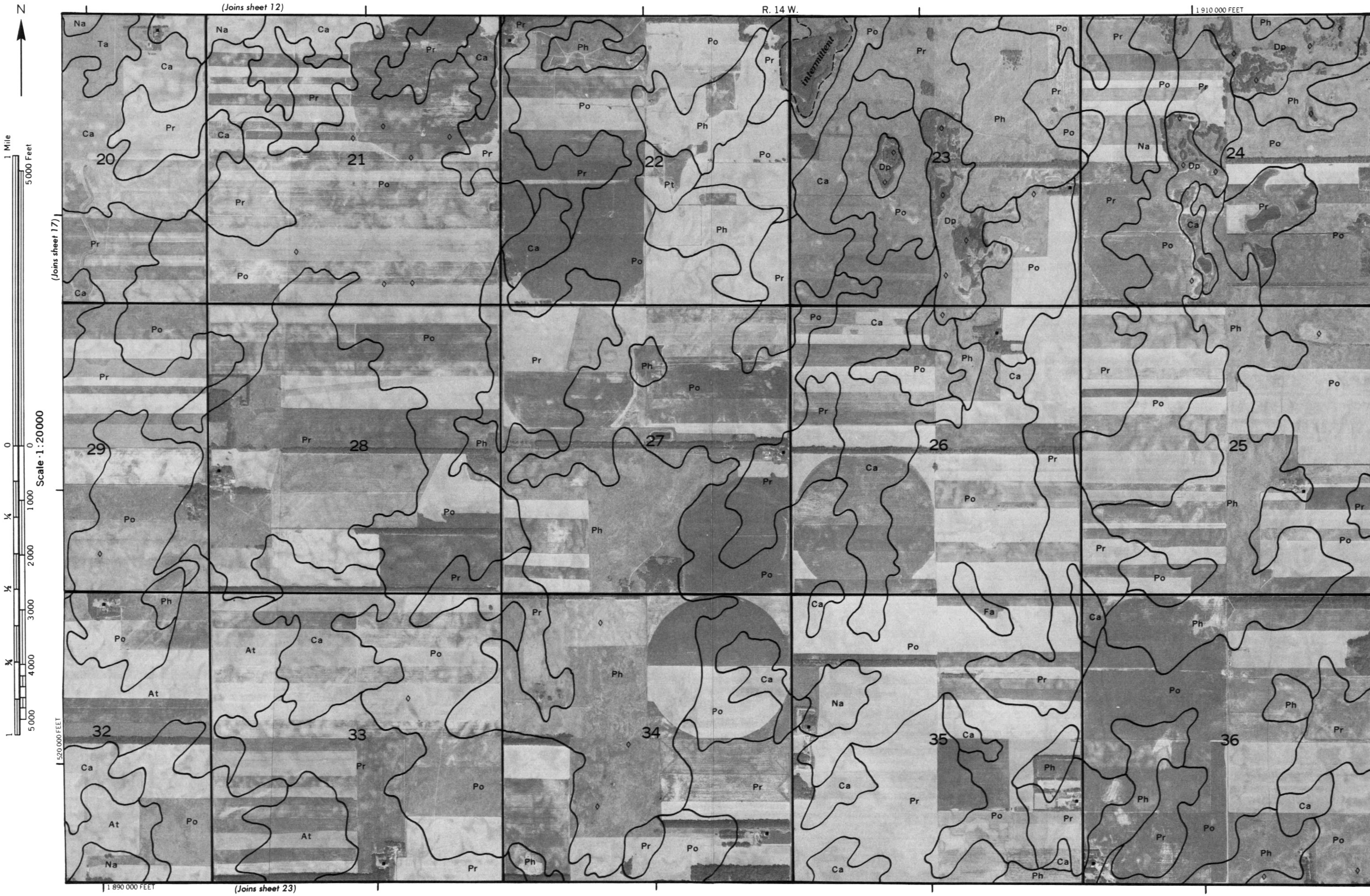


4000 AND 5000-FOOT GRID TICKS

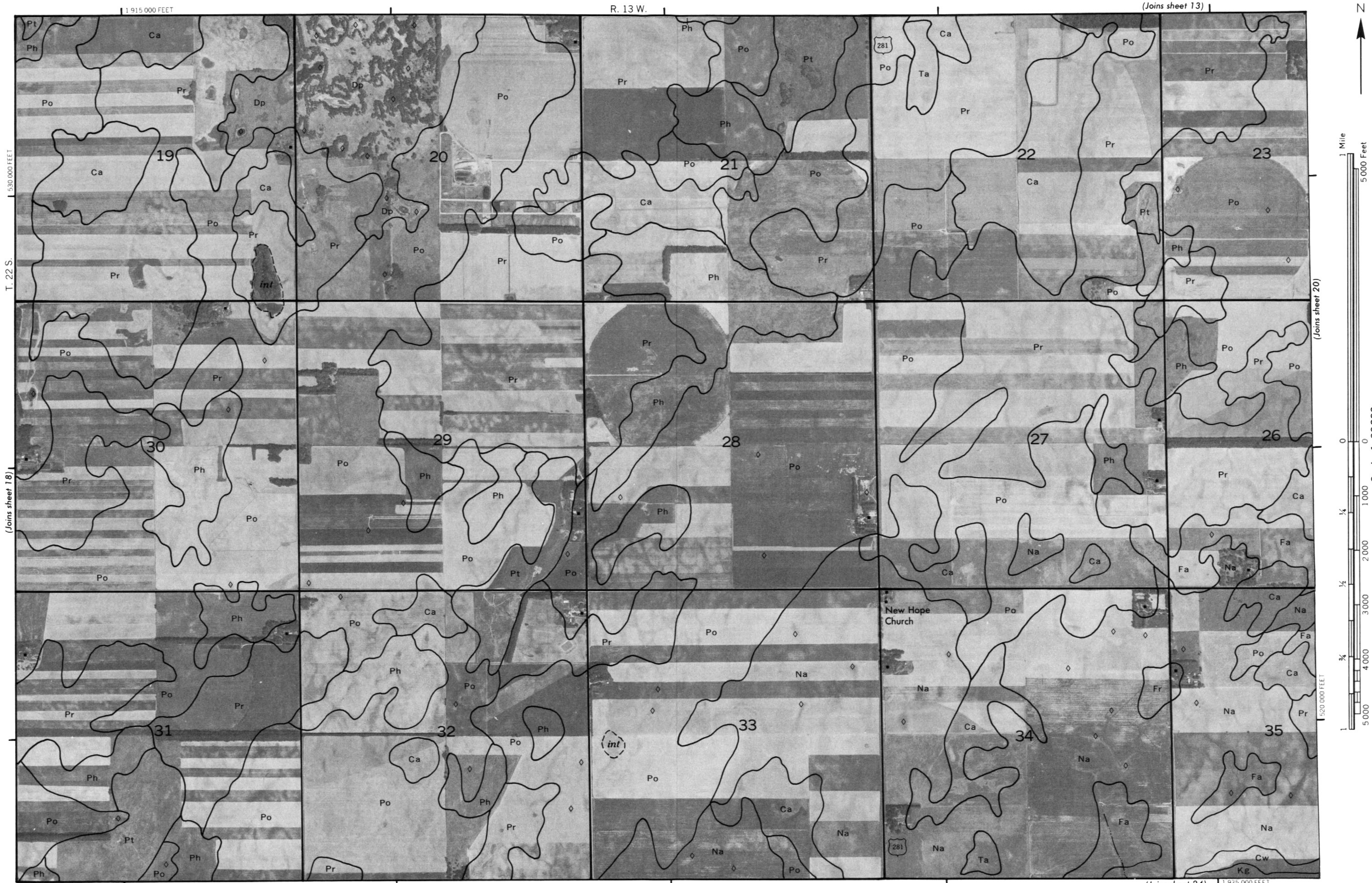
STAFFORD COUNTY, KANSAS NO. 17

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 18



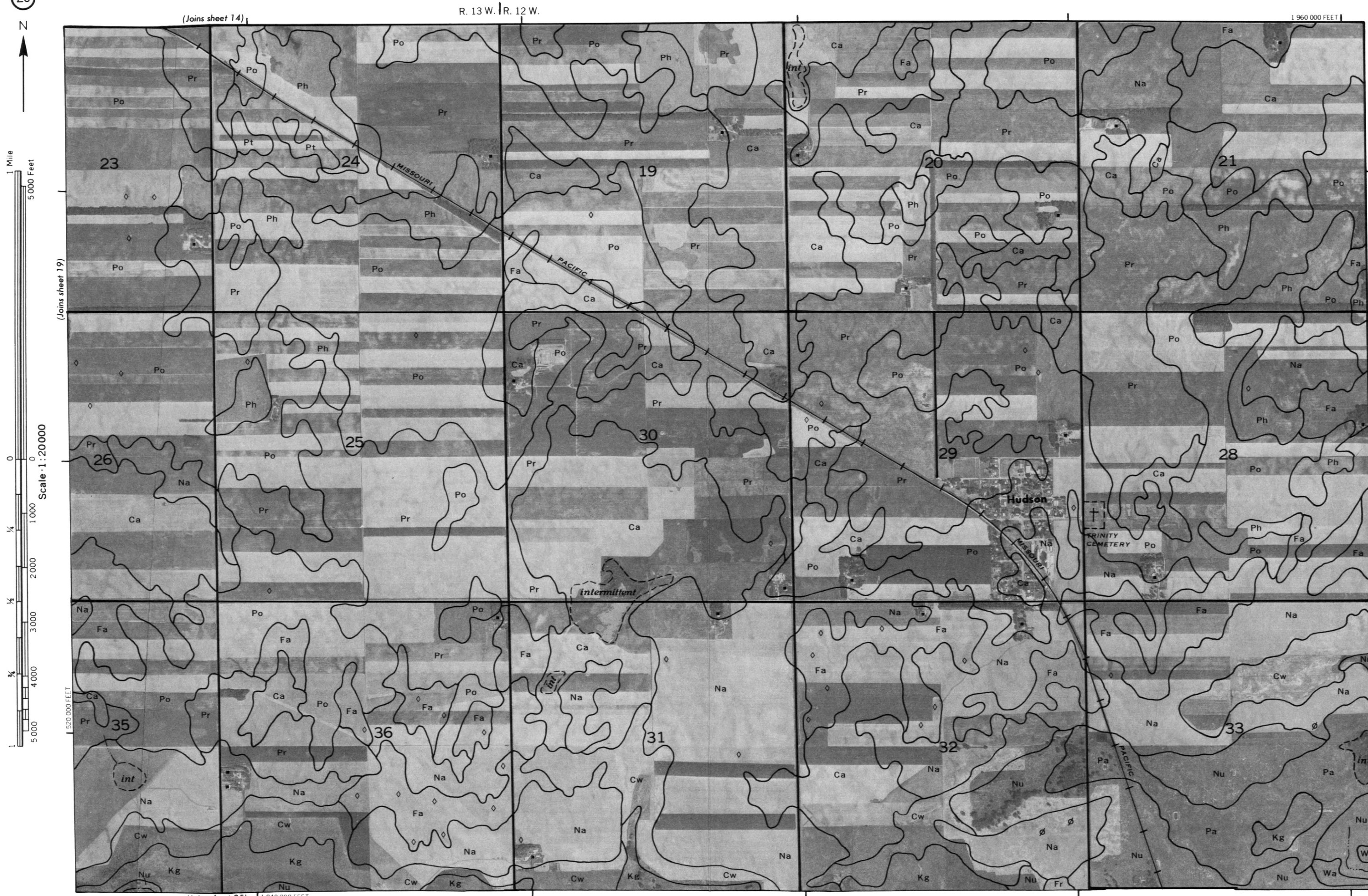
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



STAFFORD COUNTY, KANSAS NO. 19

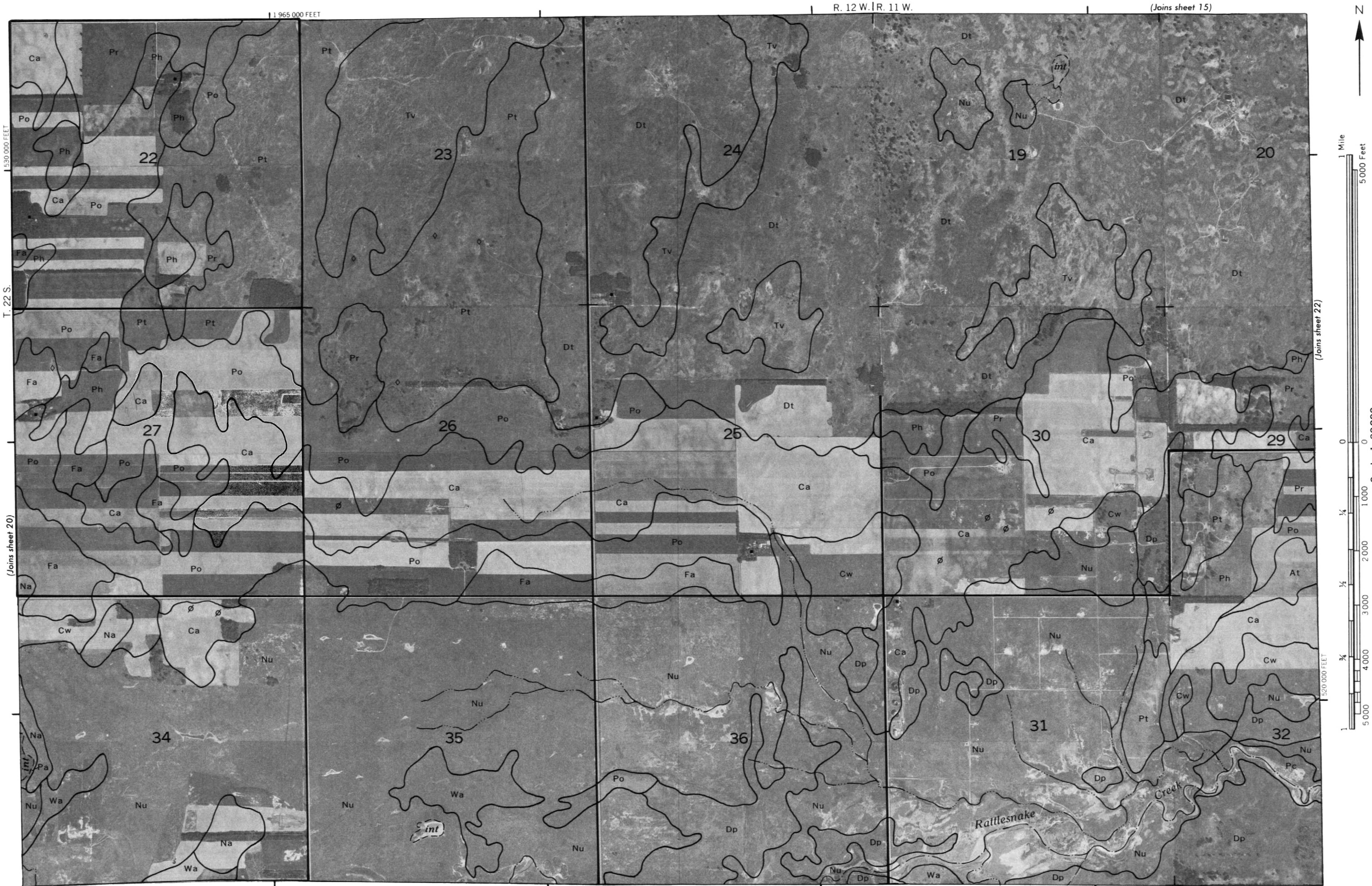
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 20



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS NO. 20



STAFFORD COUNTY, KANSAS NO. 21

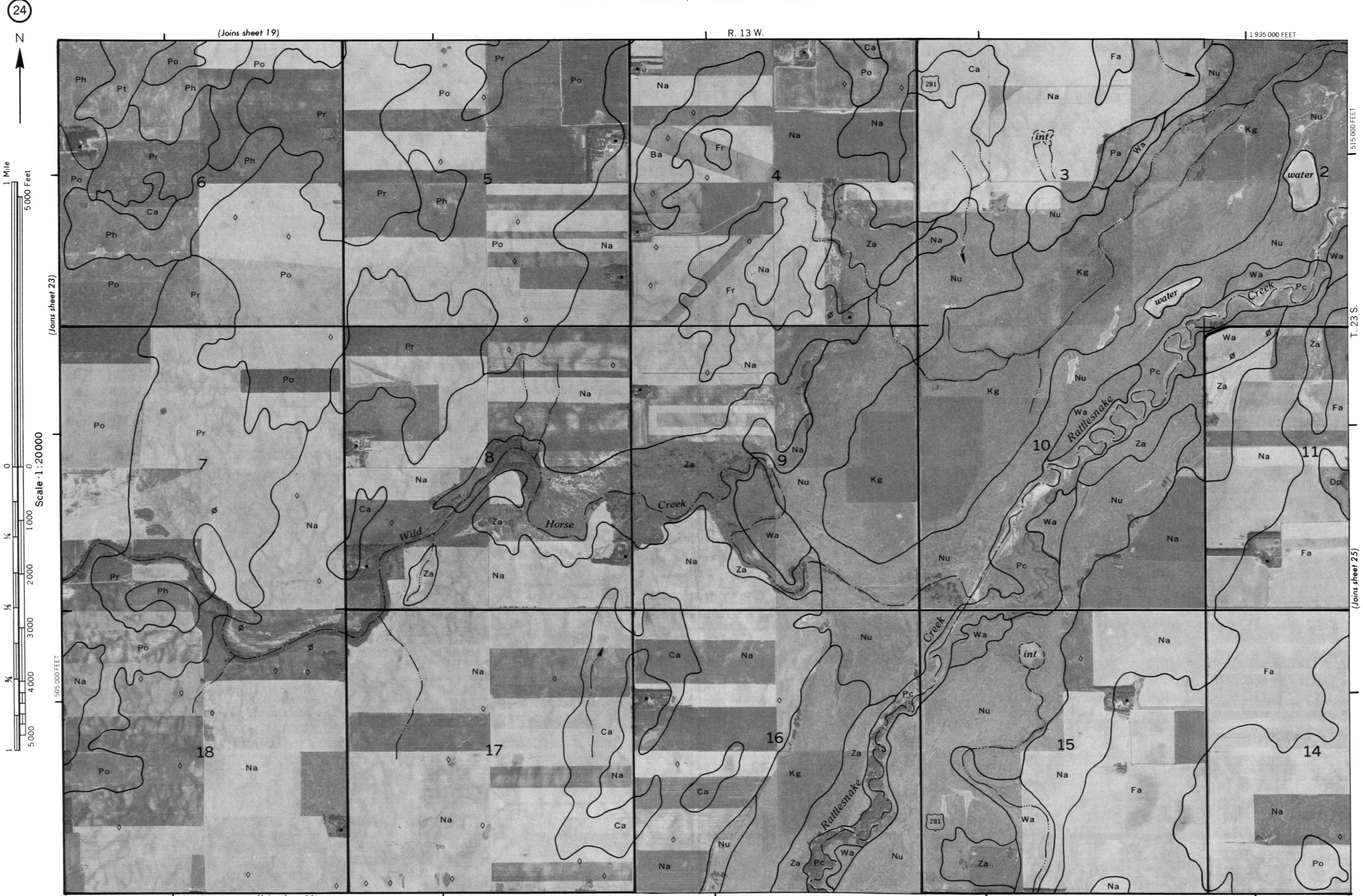
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 22

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS NO. 23

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

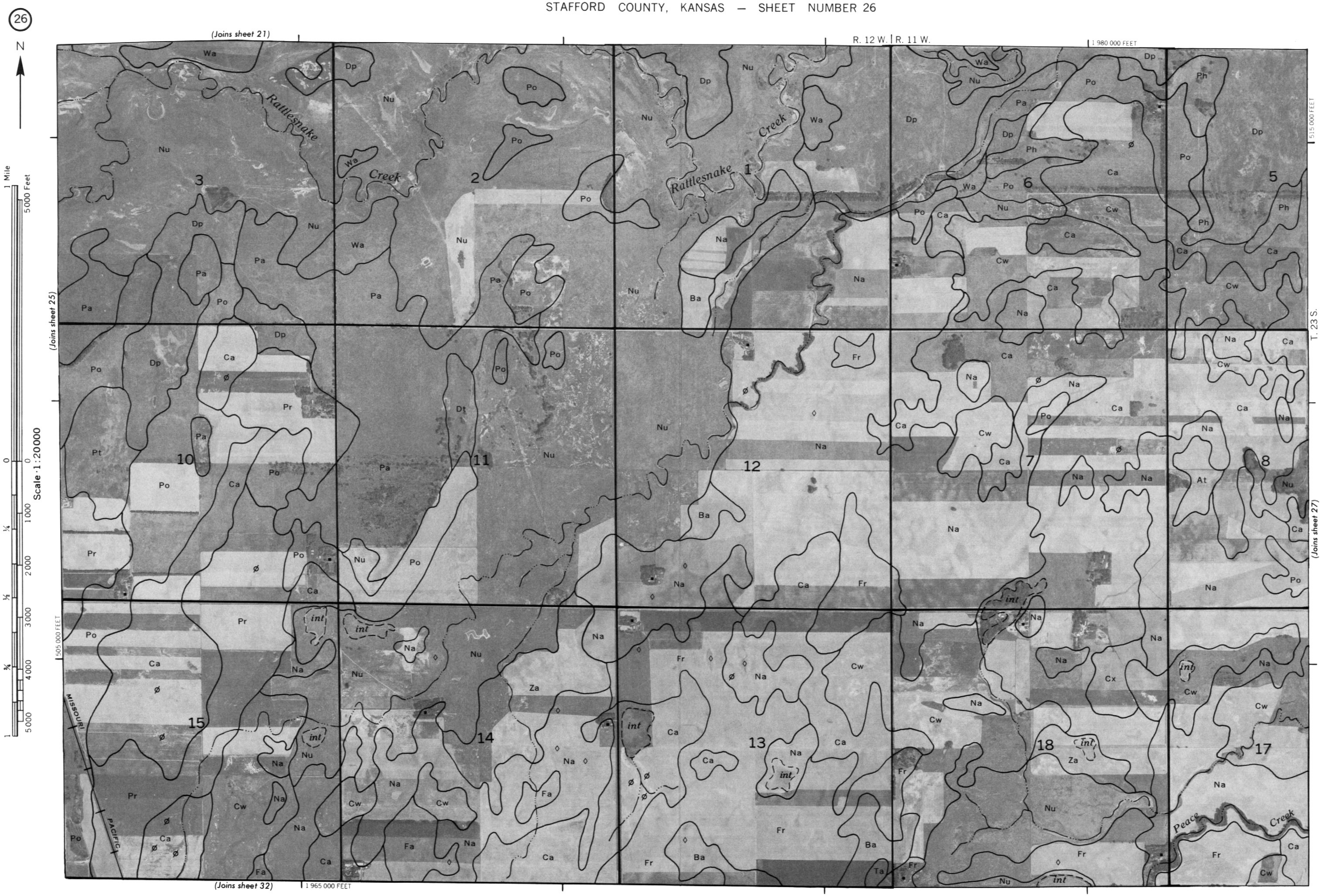


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

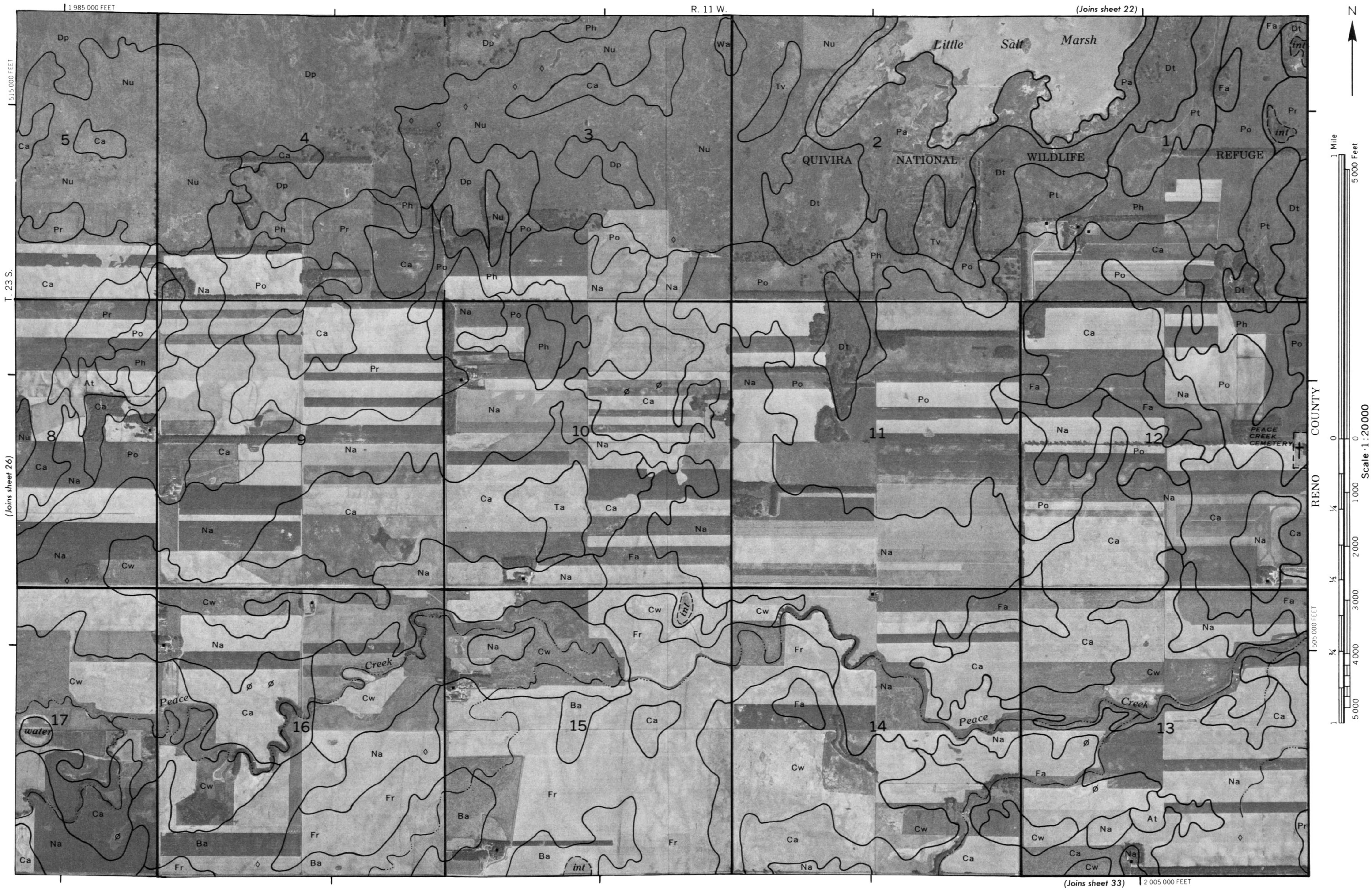
STAFFORD COUNTY, KANSAS — SHEET NUMBER 25

STAFFORD COUNTY, KANSAS NO. 25

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



STAFFORD COUNTY, KANSAS NO. 27

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

28

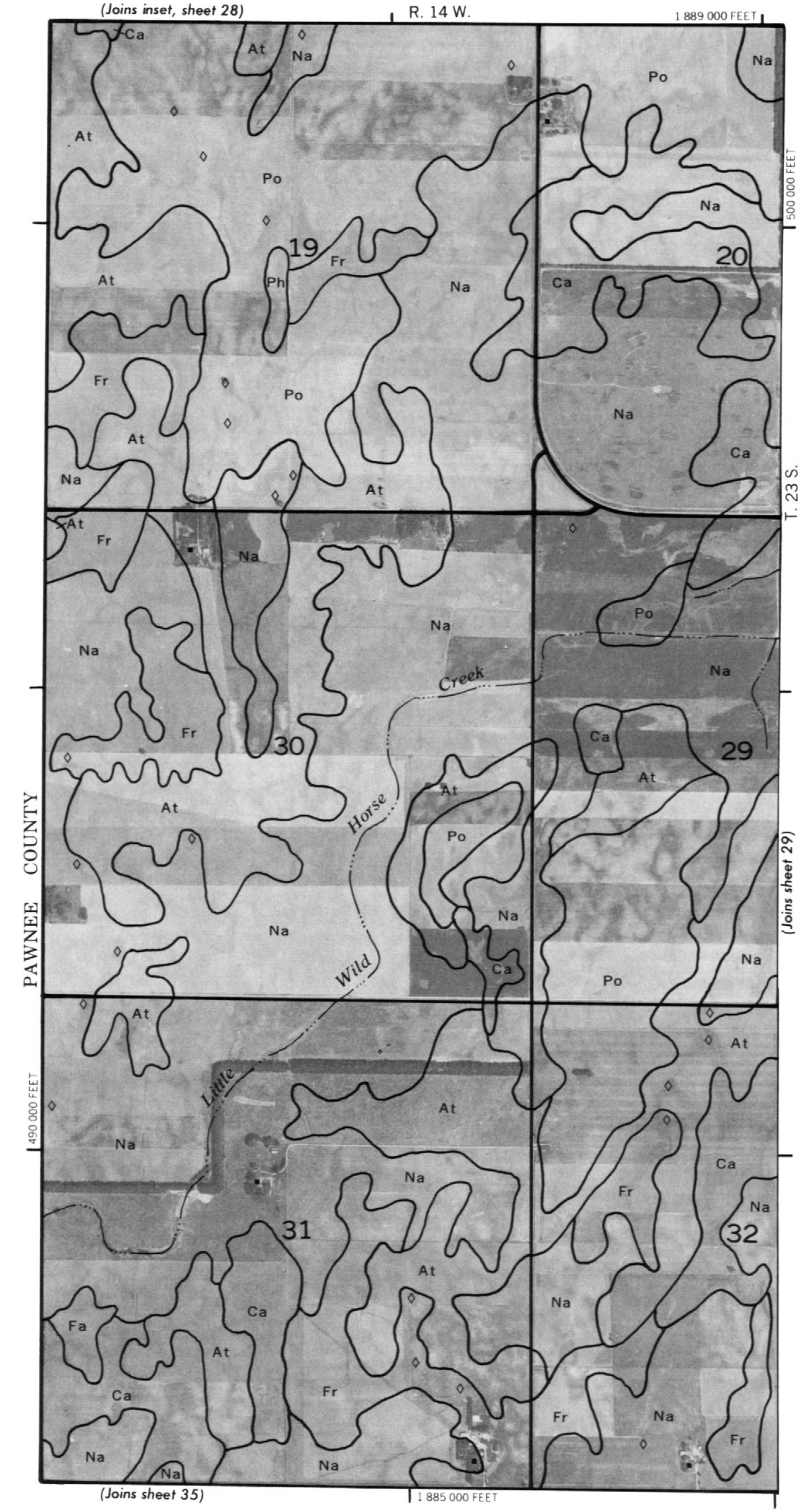
N

Scale 1:20000

1 Mile

5000 Feet

4000 AND 5000-FOOT GRID TICKS



4000 AND 5000-FOOT GRID TICKS

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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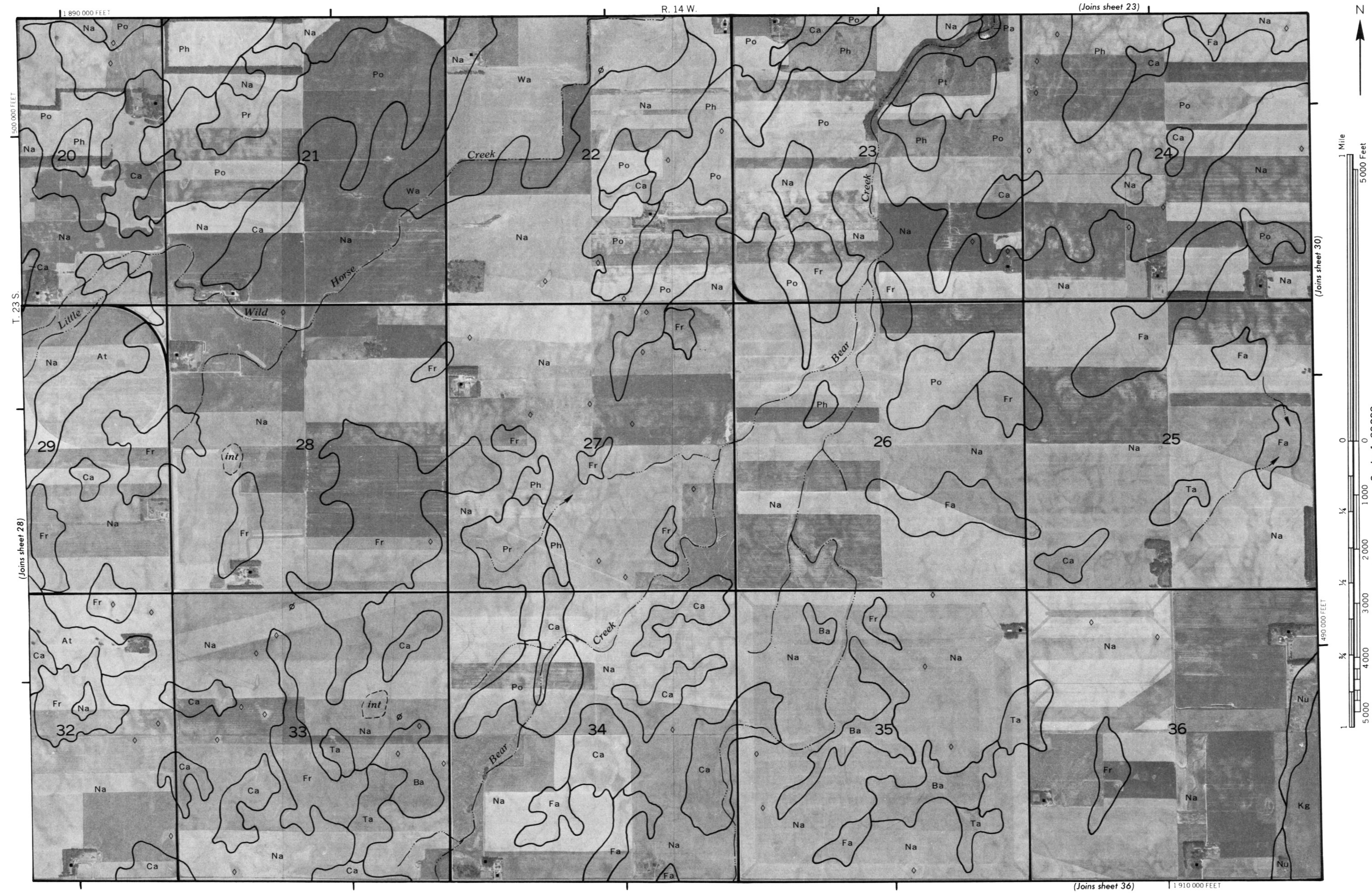
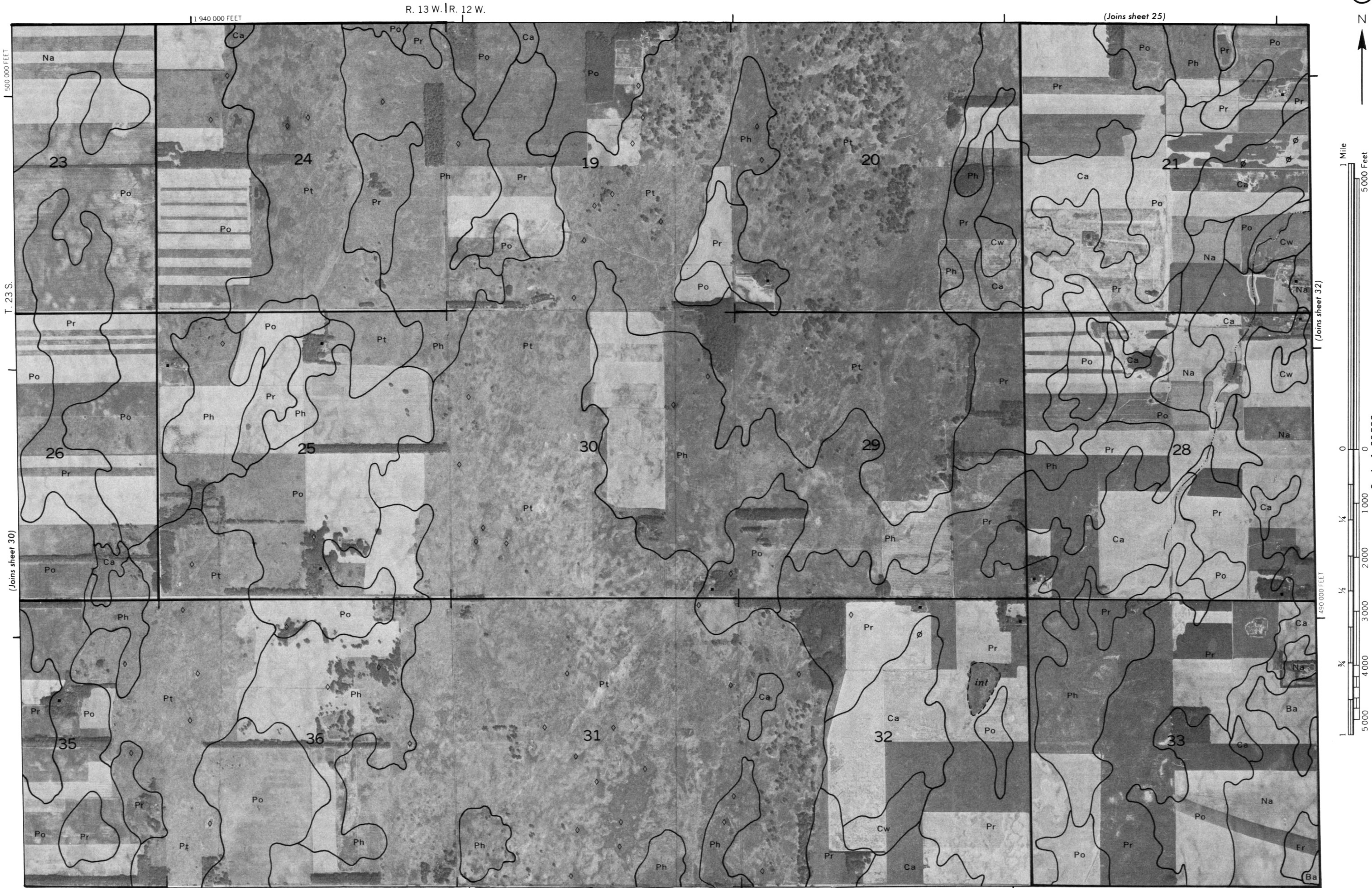


STAFFORD COUNTY, KANSAS — SHEET NUMBER 30

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

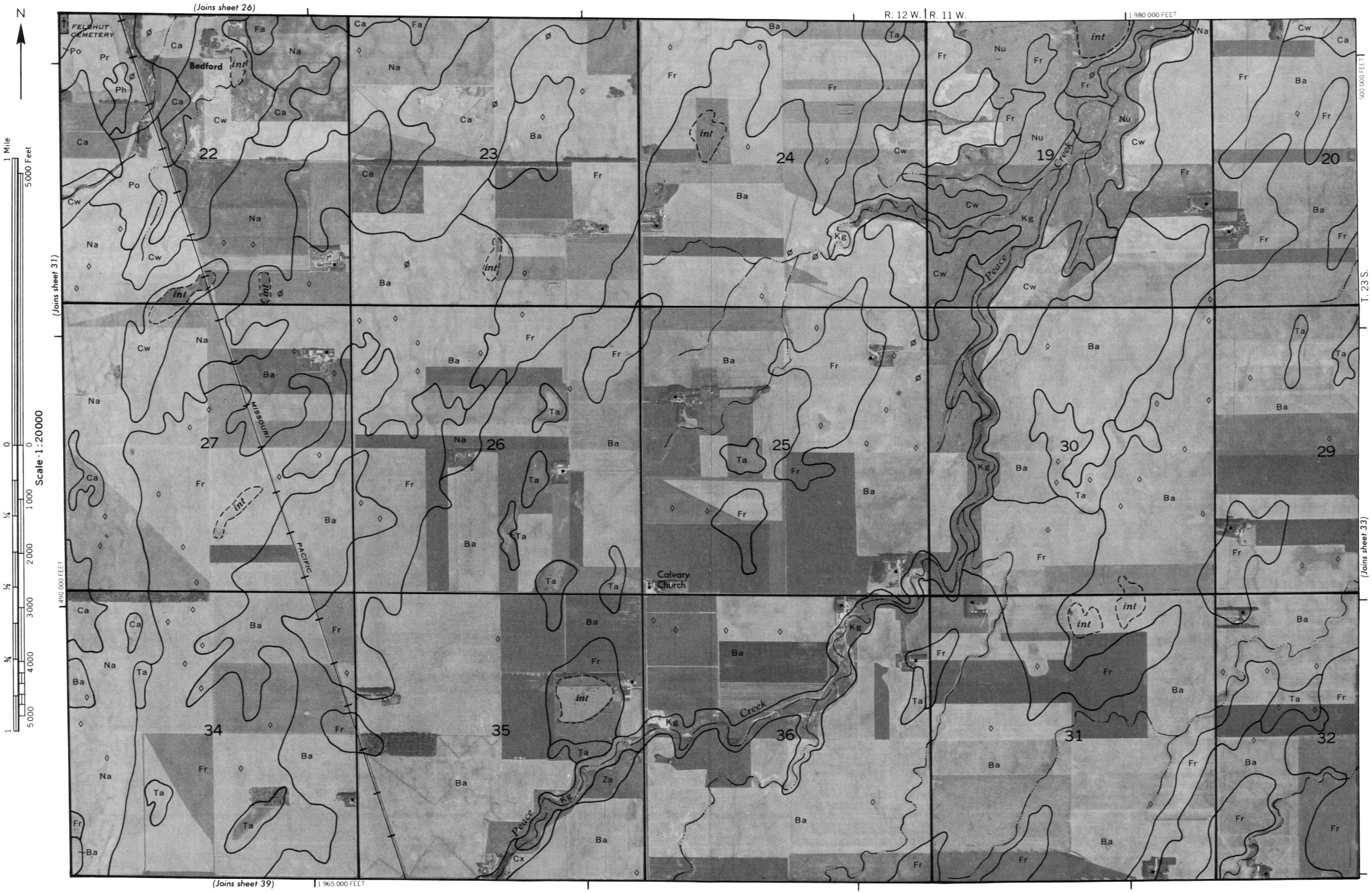
STAFFORD COUNTY, KANSAS NO. 30



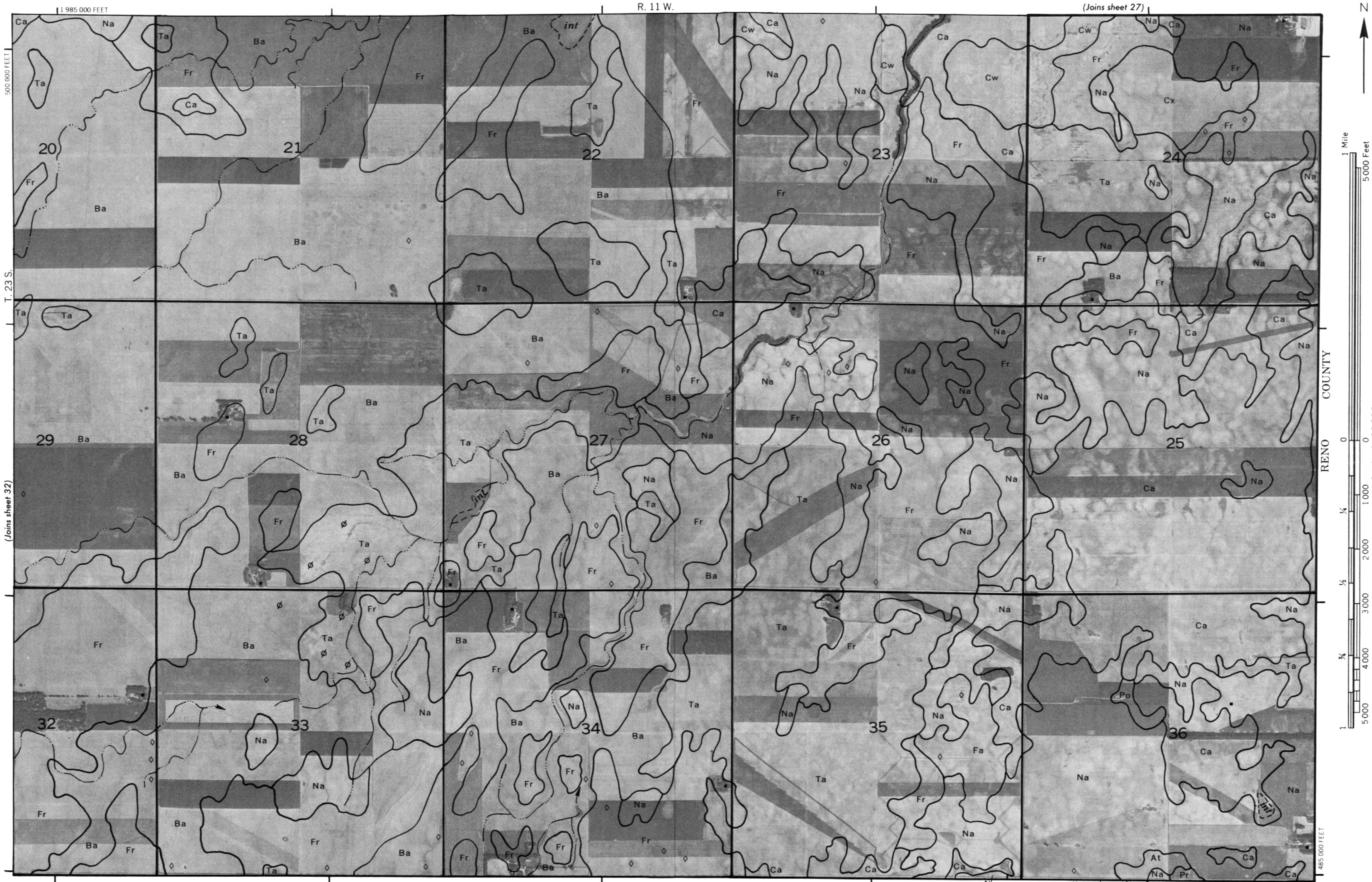
STAFFORD COUNTY, KANSAS NO. 31

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 32

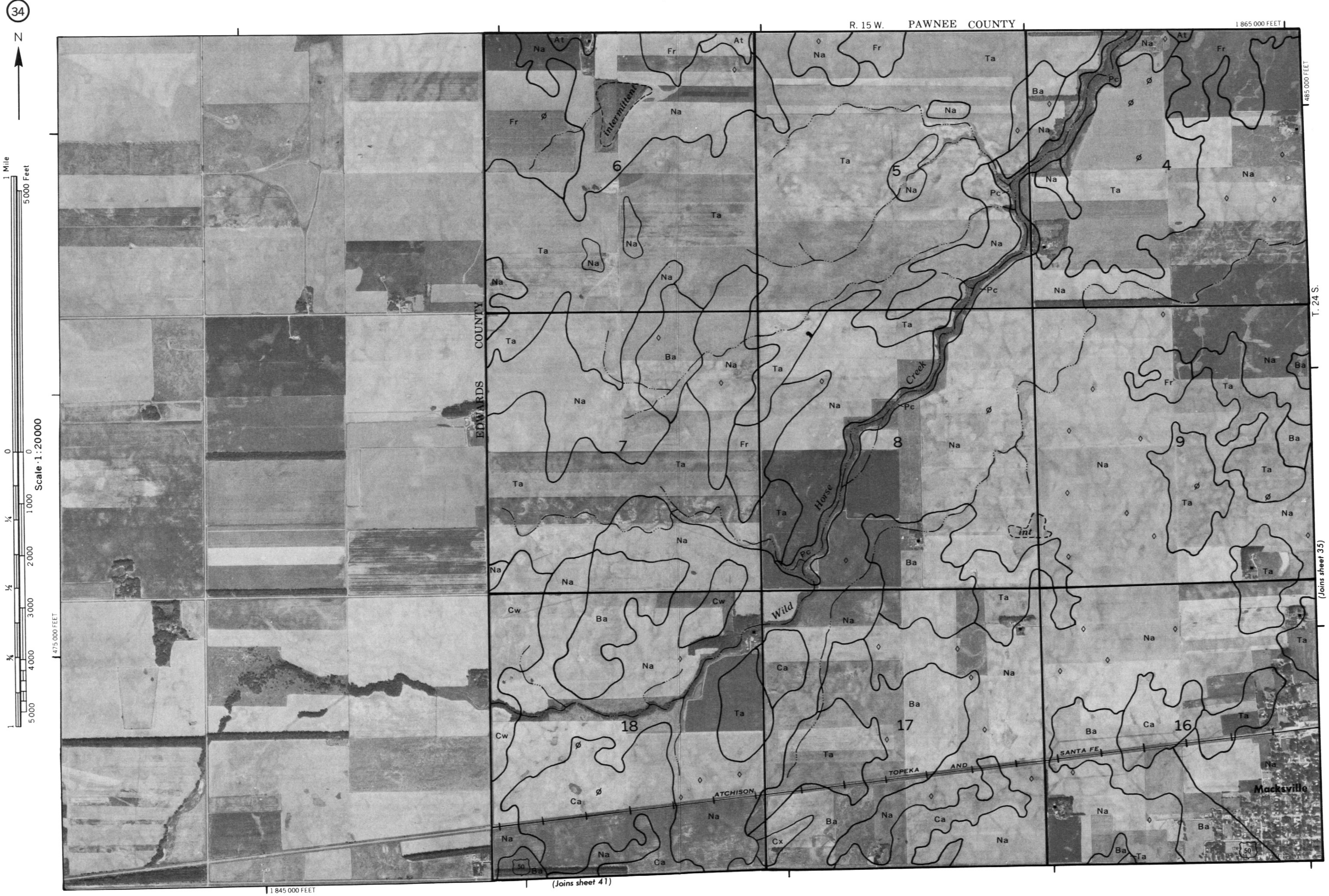


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



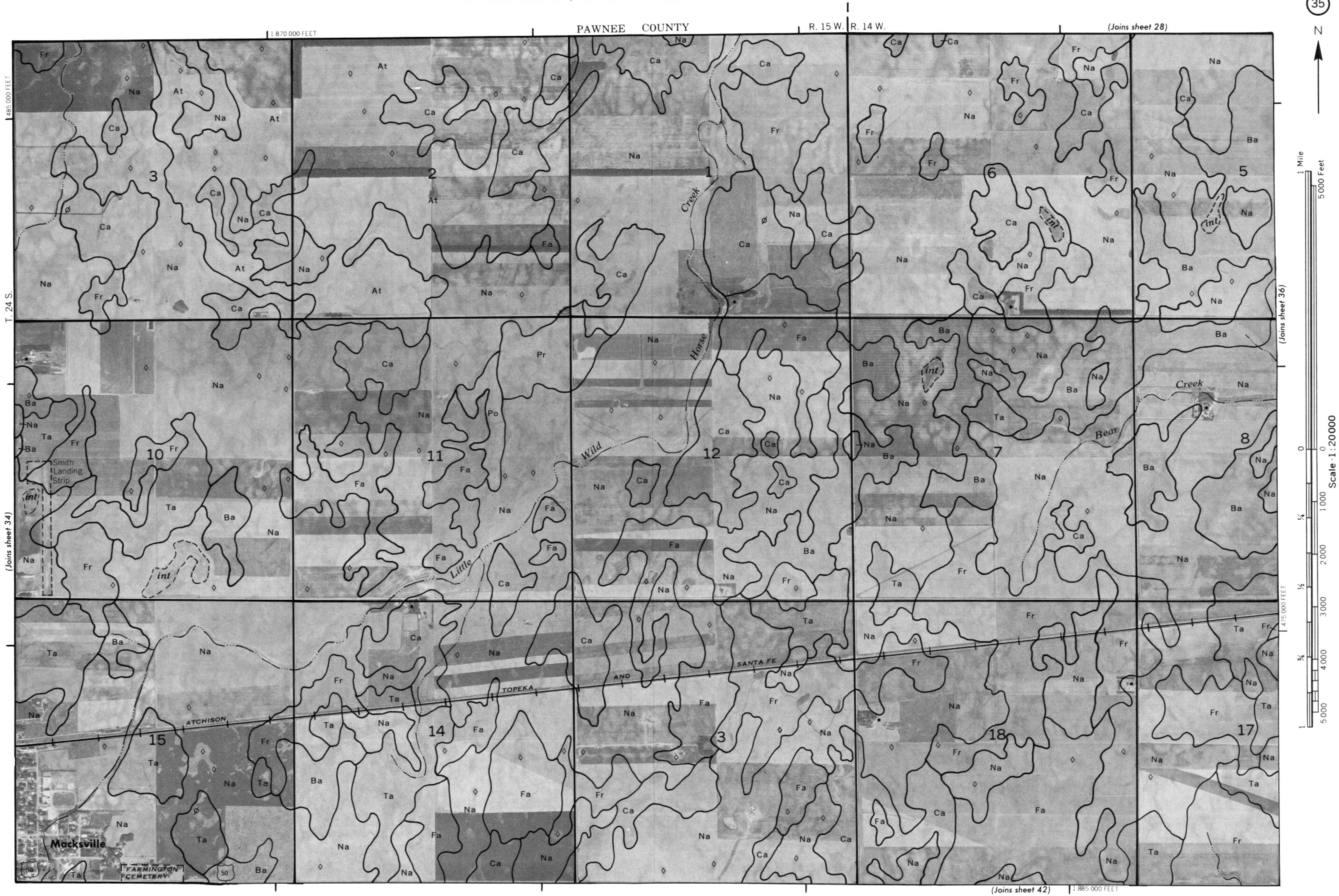
STAFFORD COUNTY, KANSAS NO. 33

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

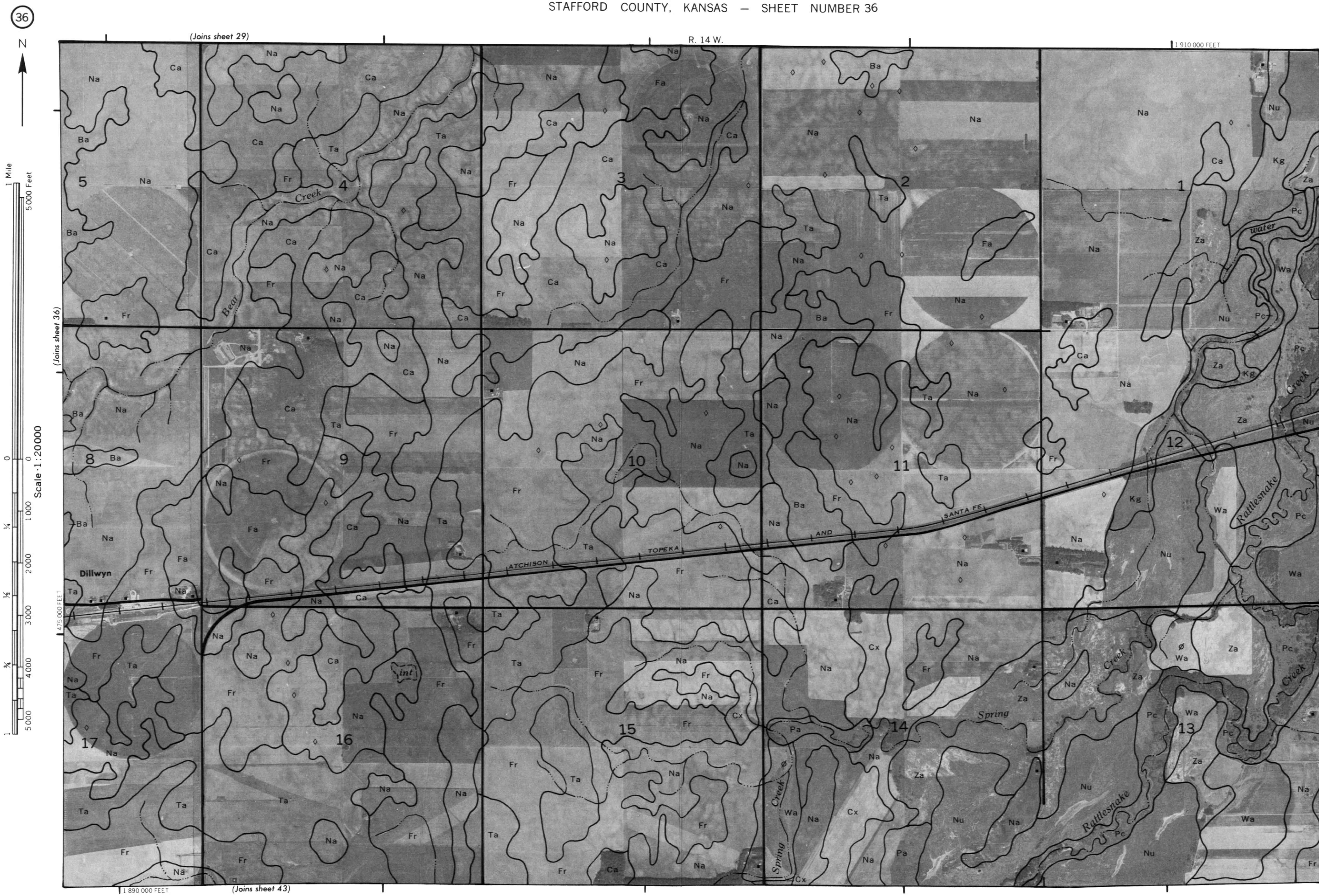
STAFFORD COUNTY, KANSAS NO. 34



STAFFORD COUNTY, KANSAS NO. 35

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

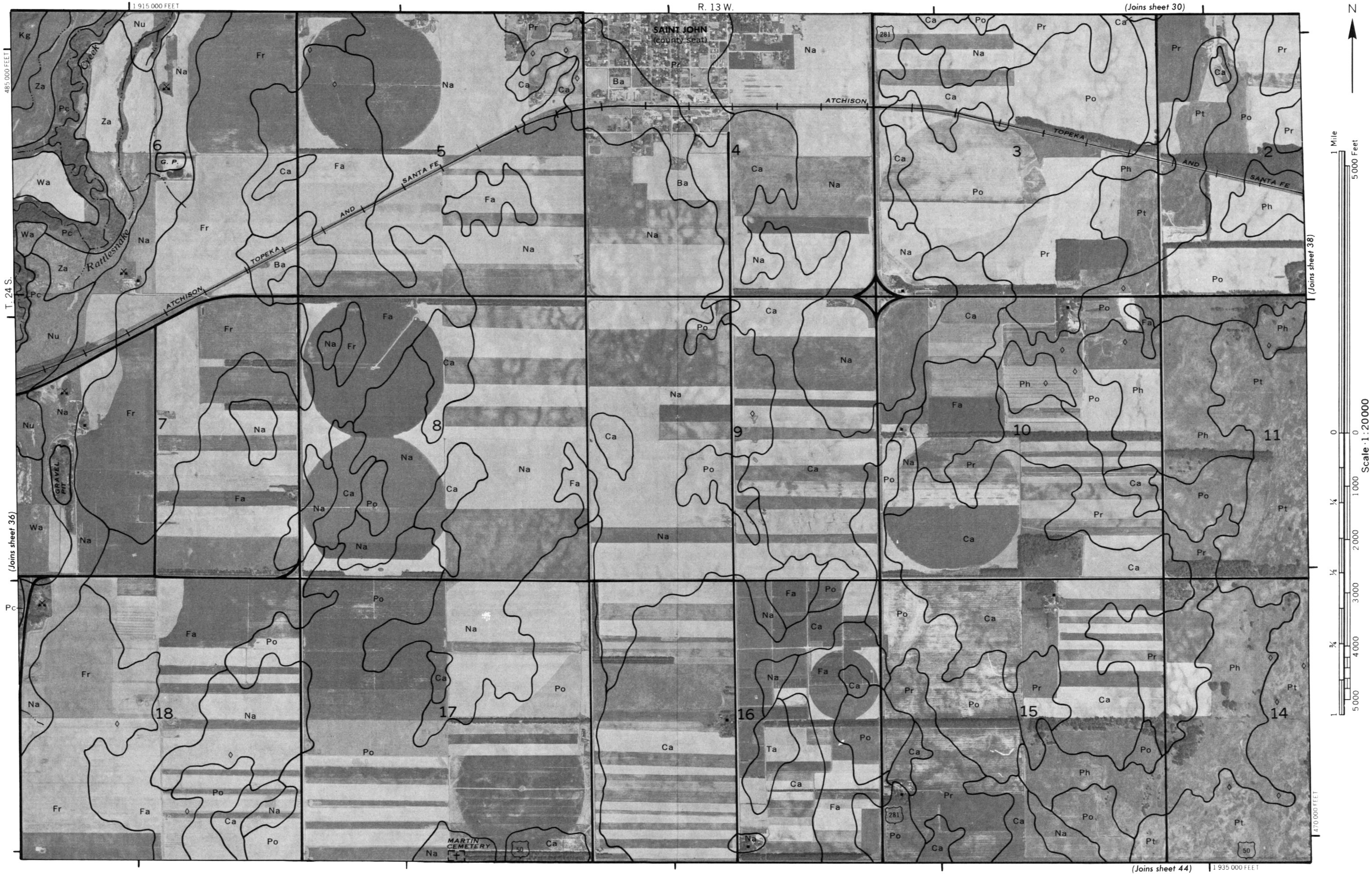
STAFFORD COUNTY, KANSAS — SHEET NUMBER 36



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS NO. 36

STAFFORD COUNTY, KANSAS — SHEET NUMBER 37



STAFFORD COUNTY, KANSAS NO. 37

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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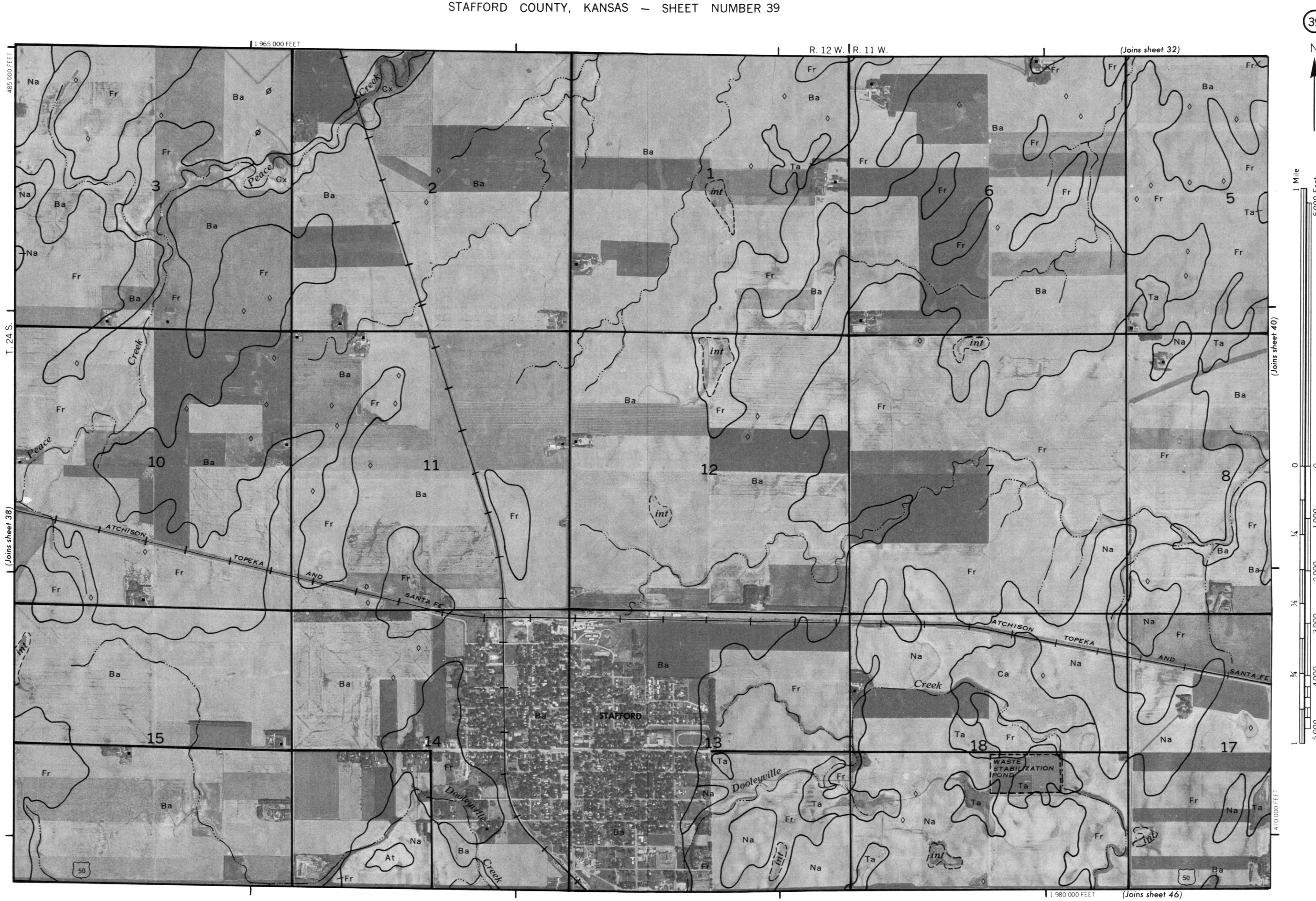
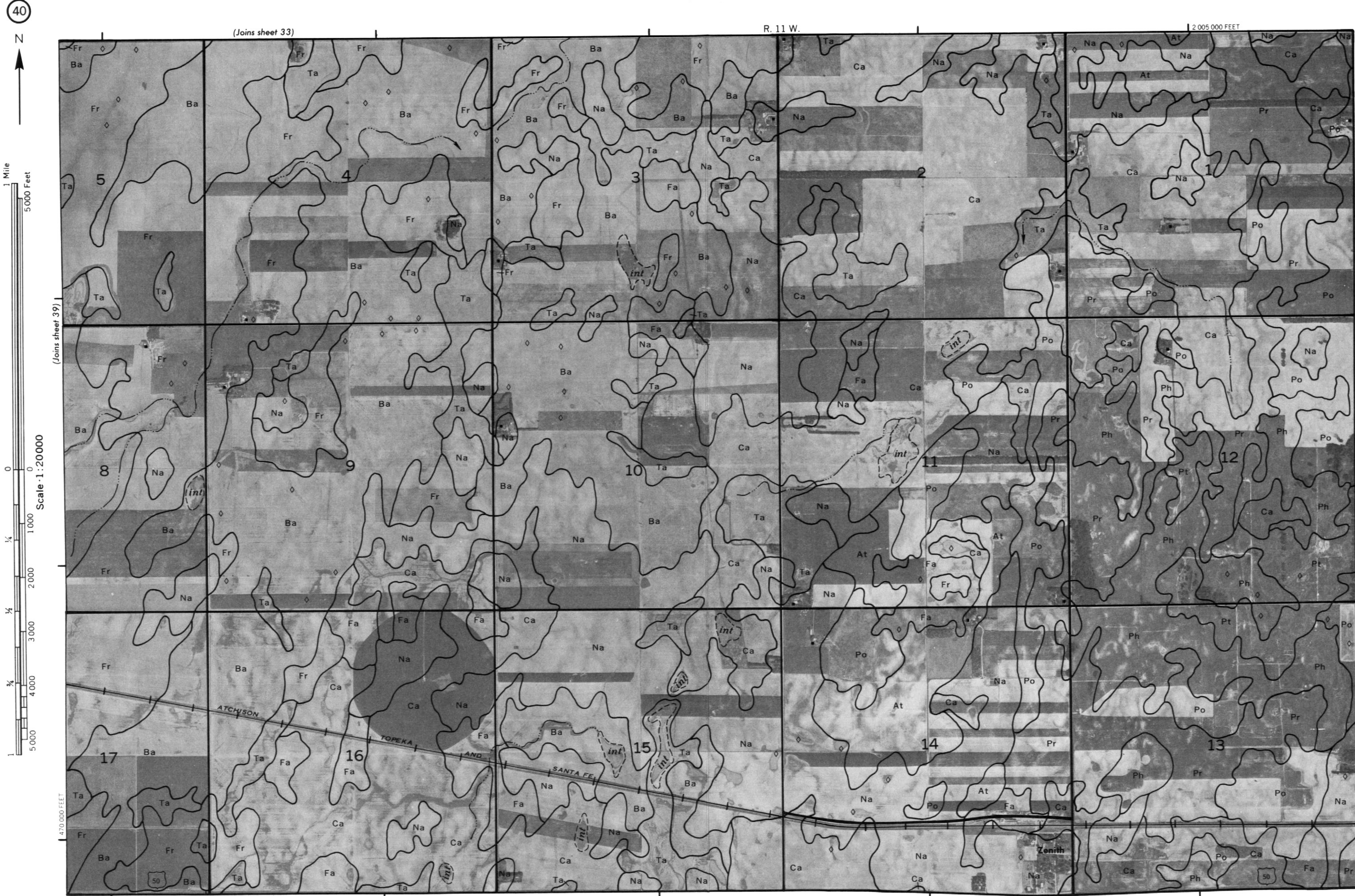
STAFFORD COUNTY, KANSAS NO. 38

STAFFORD COUNTY, KANSAS — SHEET NUMBER 39

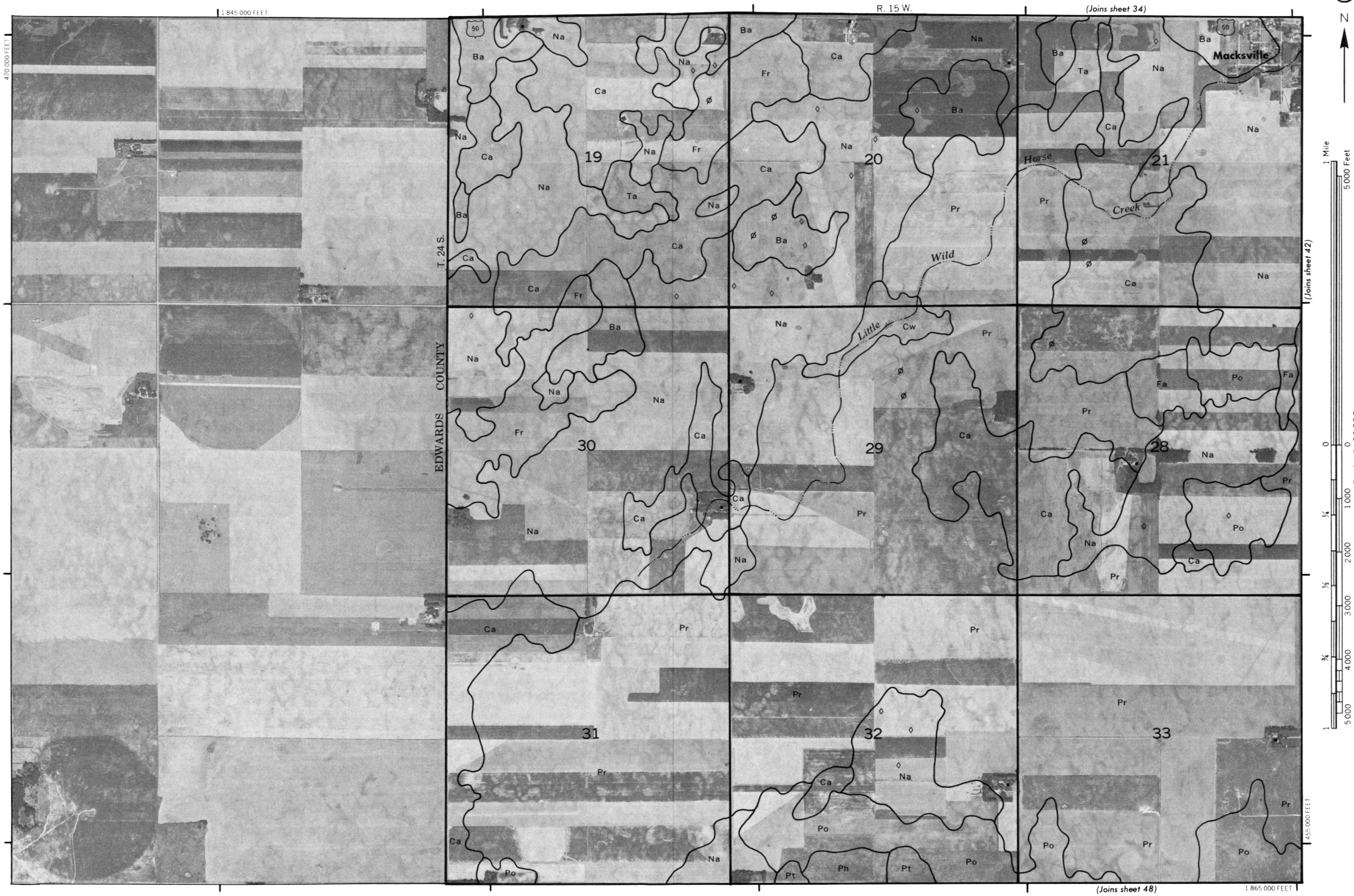


STAFFORD COUNTY, KANSAS NO. 39

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



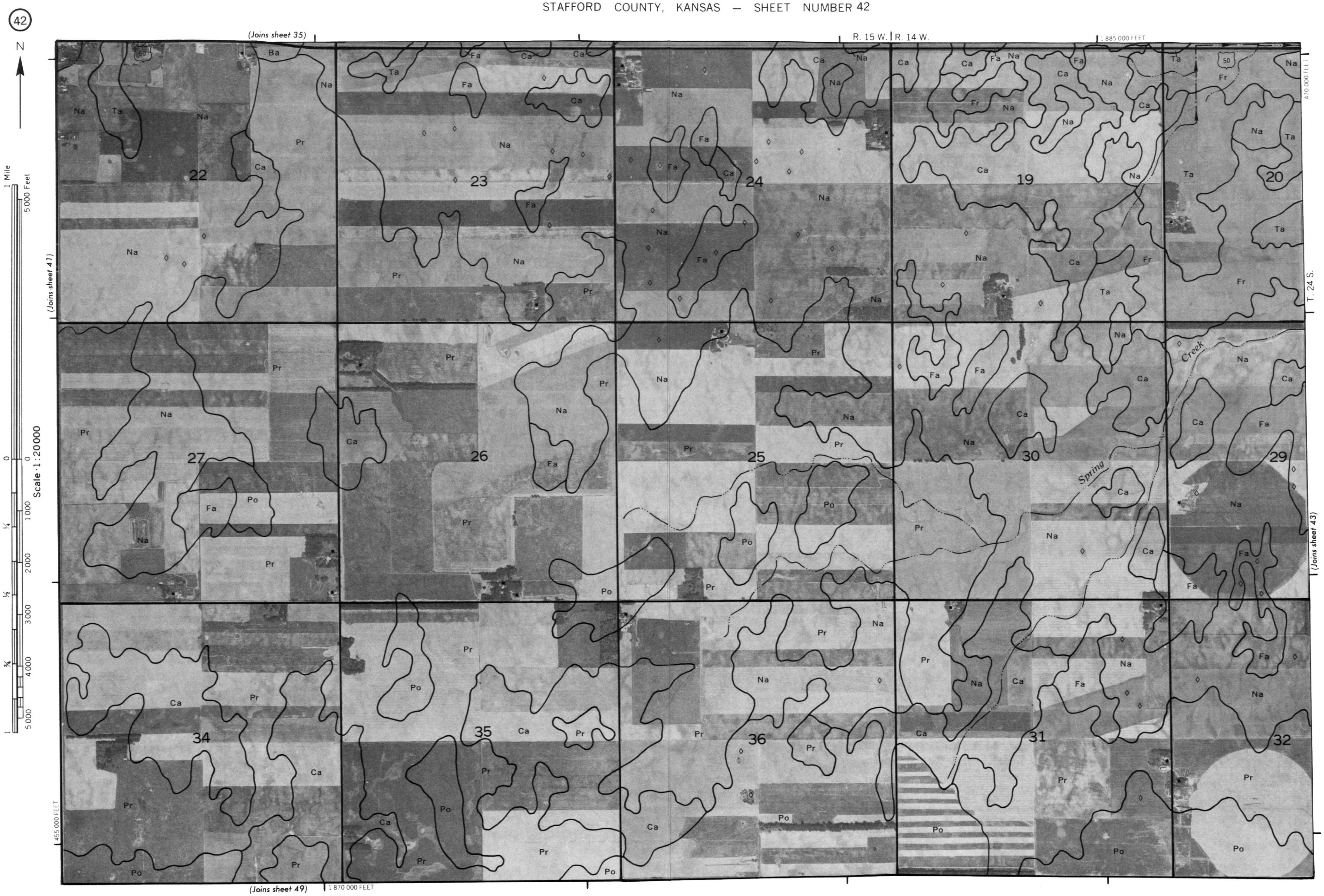
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



STAFFORD COUNTY, KANSAS NO. 41

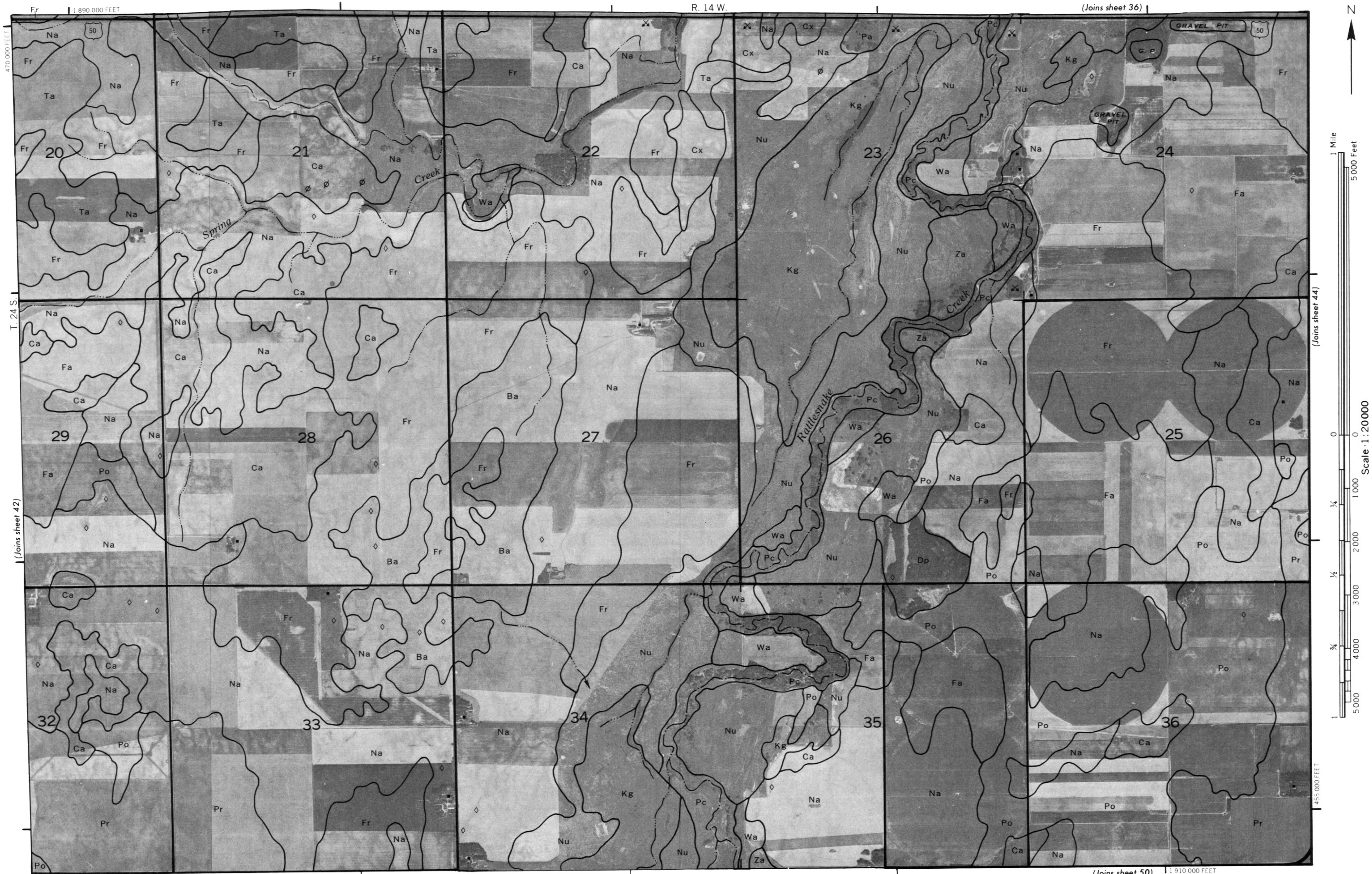
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 42



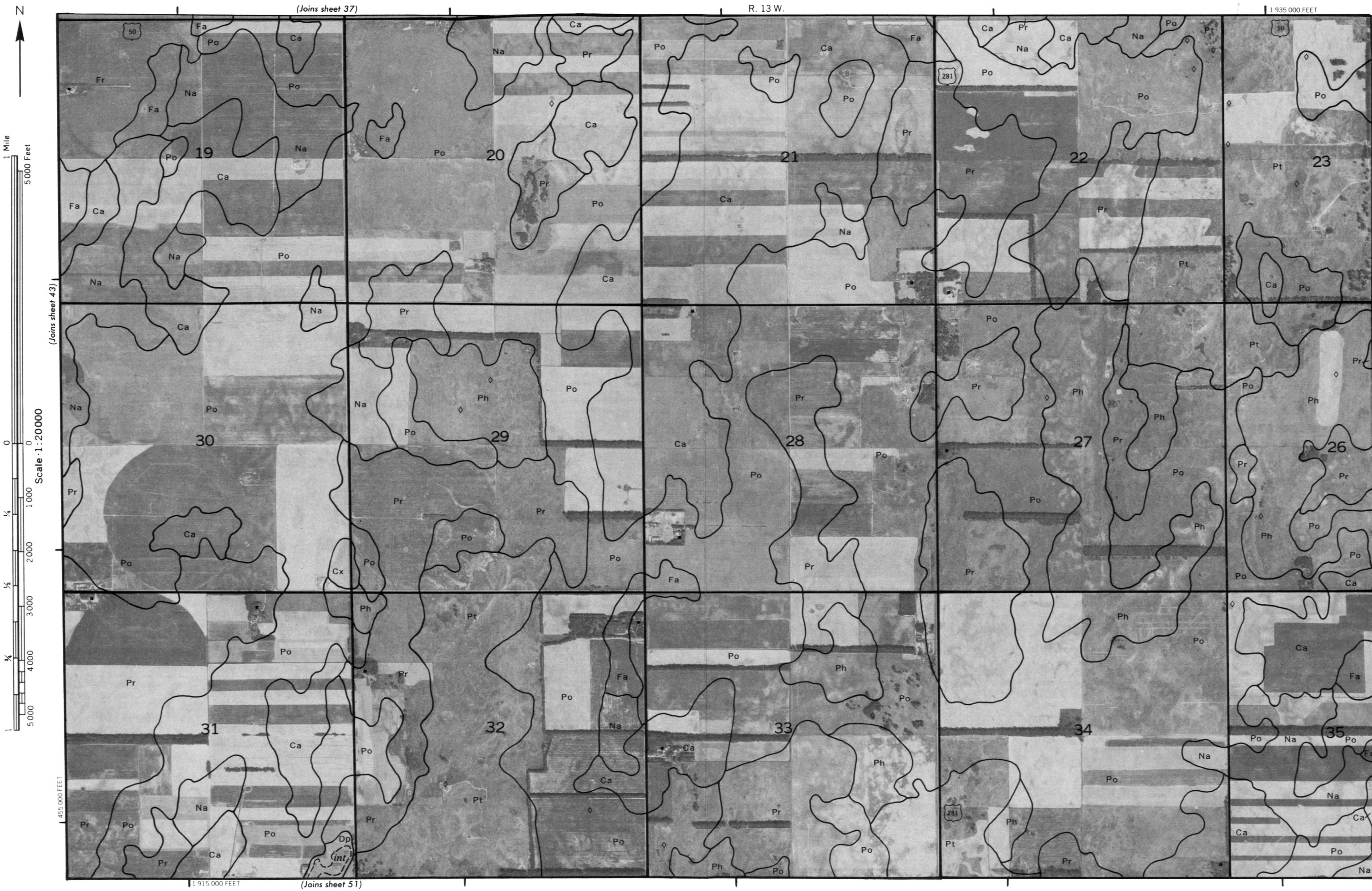
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS NO. 42



STAFFORD COUNTY, KANSAS NO. 43
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

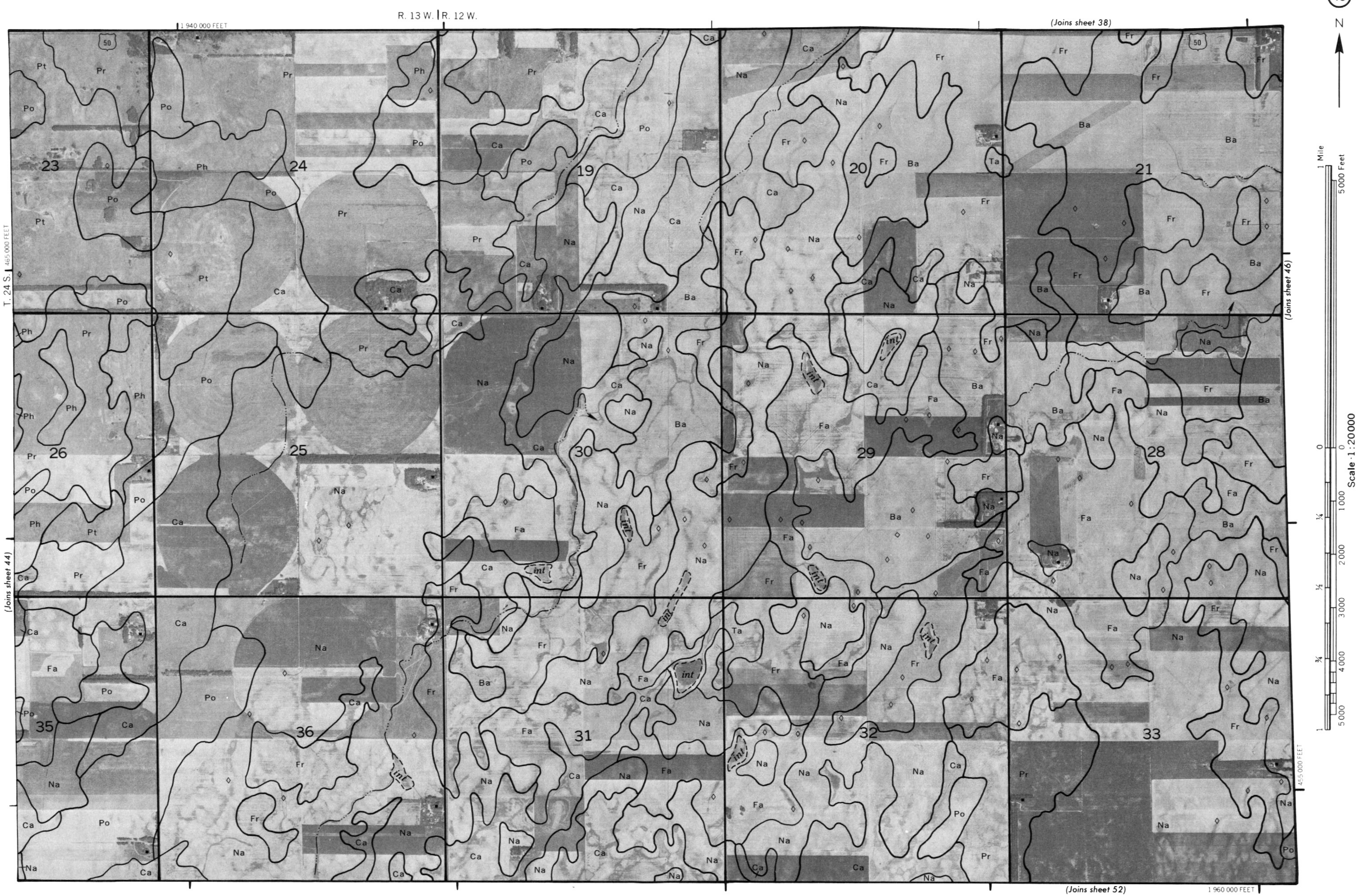
STAFFORD COUNTY, KANSAS — SHEET NUMBER 44



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

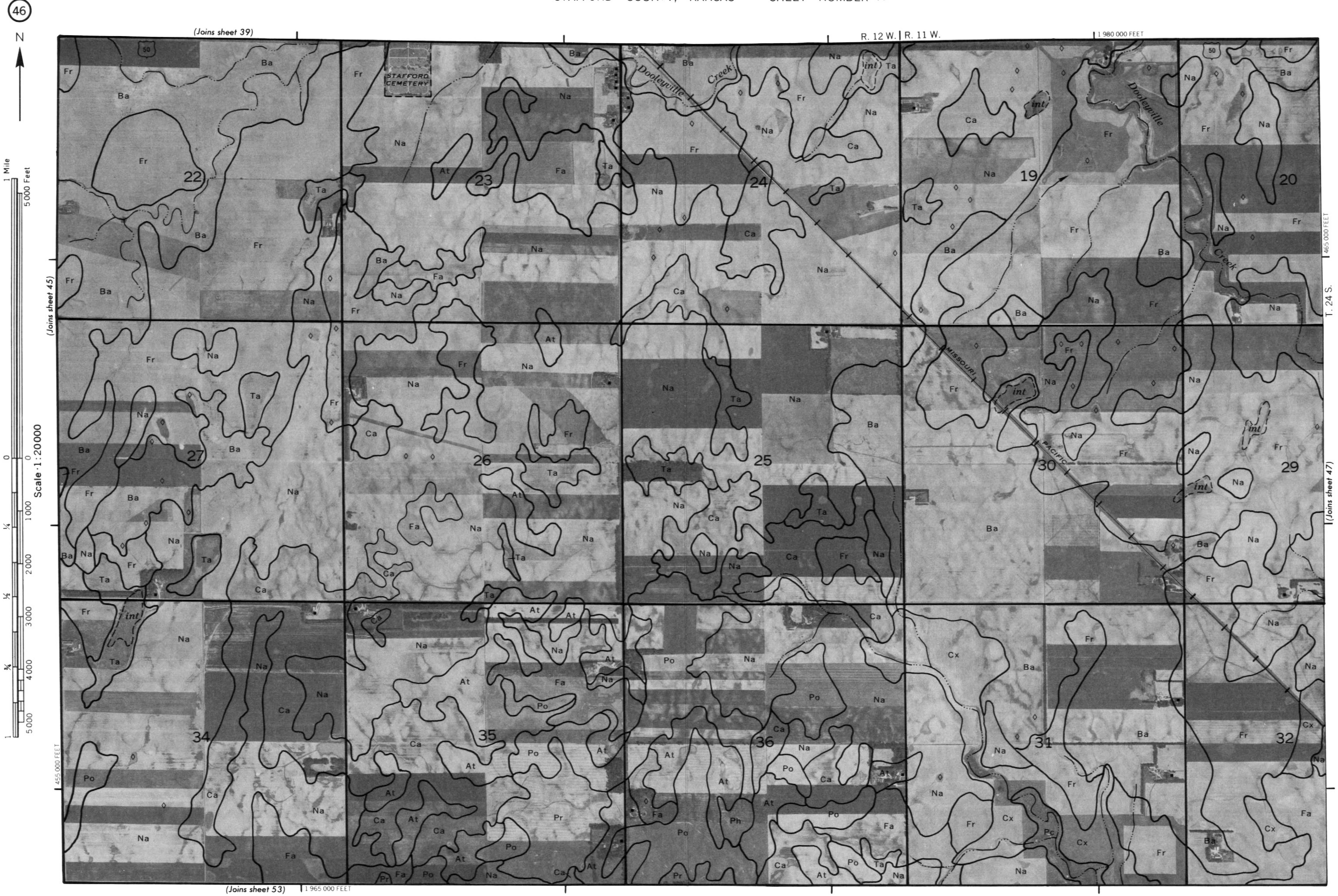
STAFFORD COUNTY, KANSAS NO. 44

STAFFORD COUNTY, KANSAS — SHEET NUMBER 45

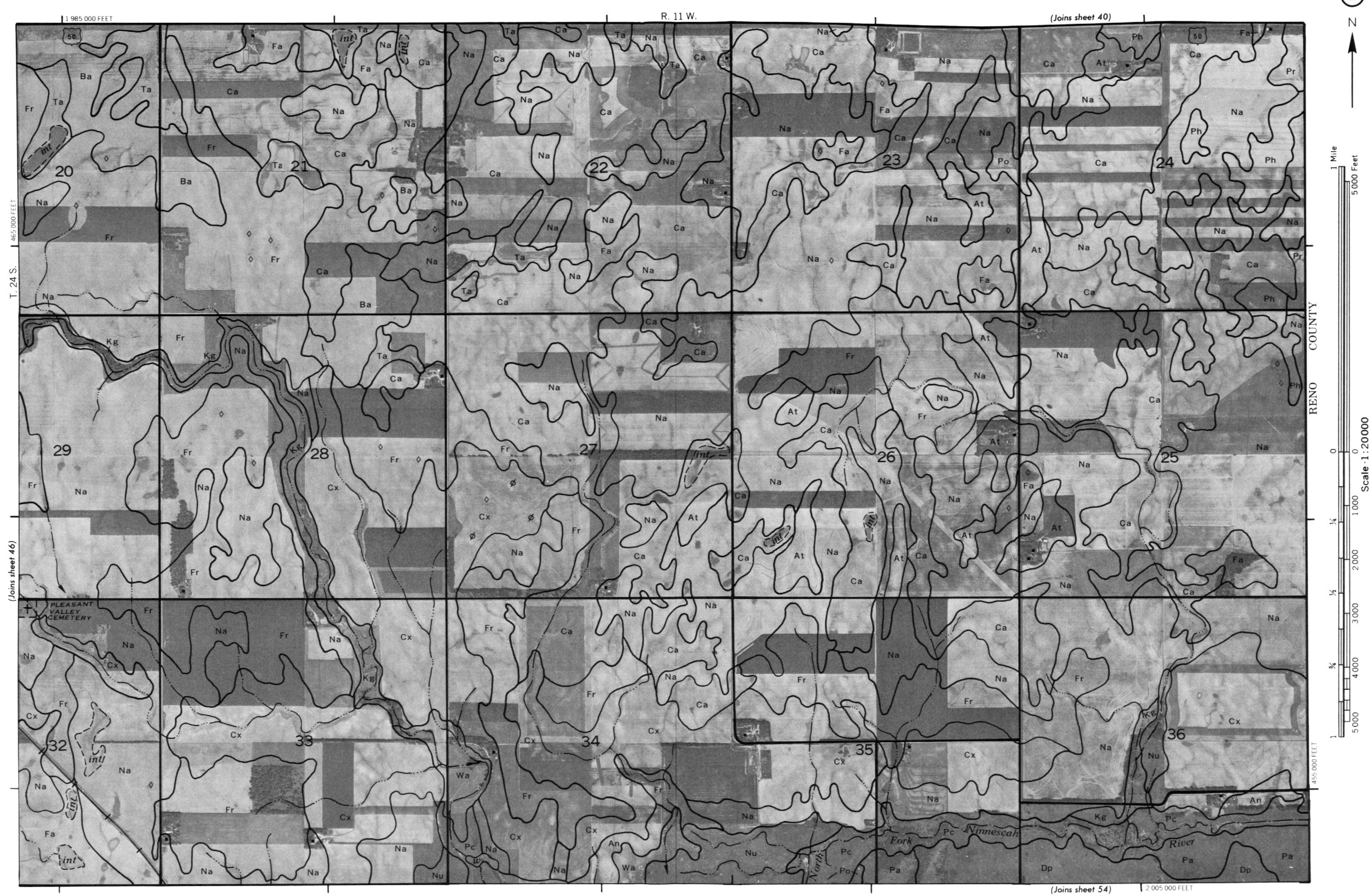


STAFFORD COUNTY, KANSAS NO. 45

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

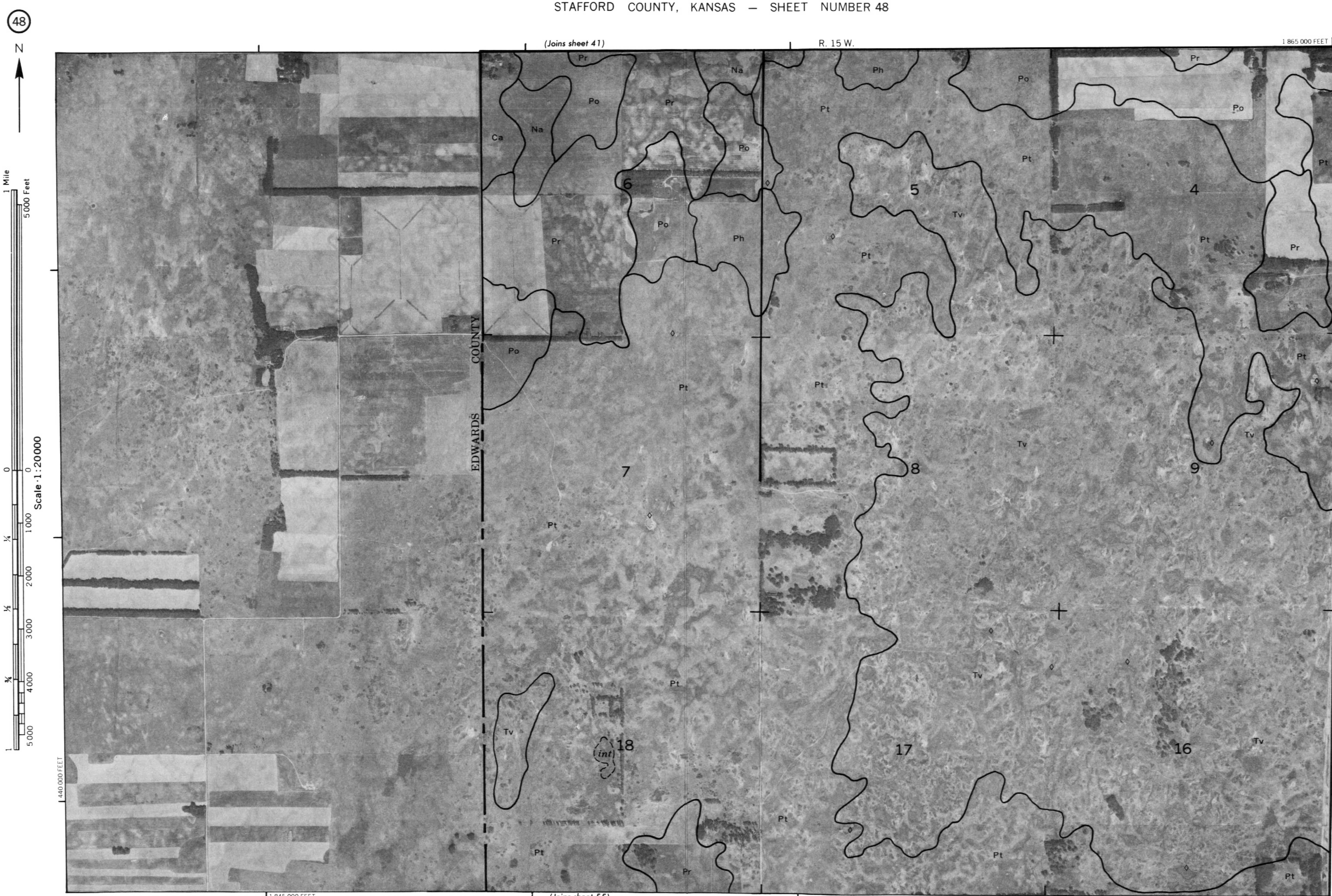


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



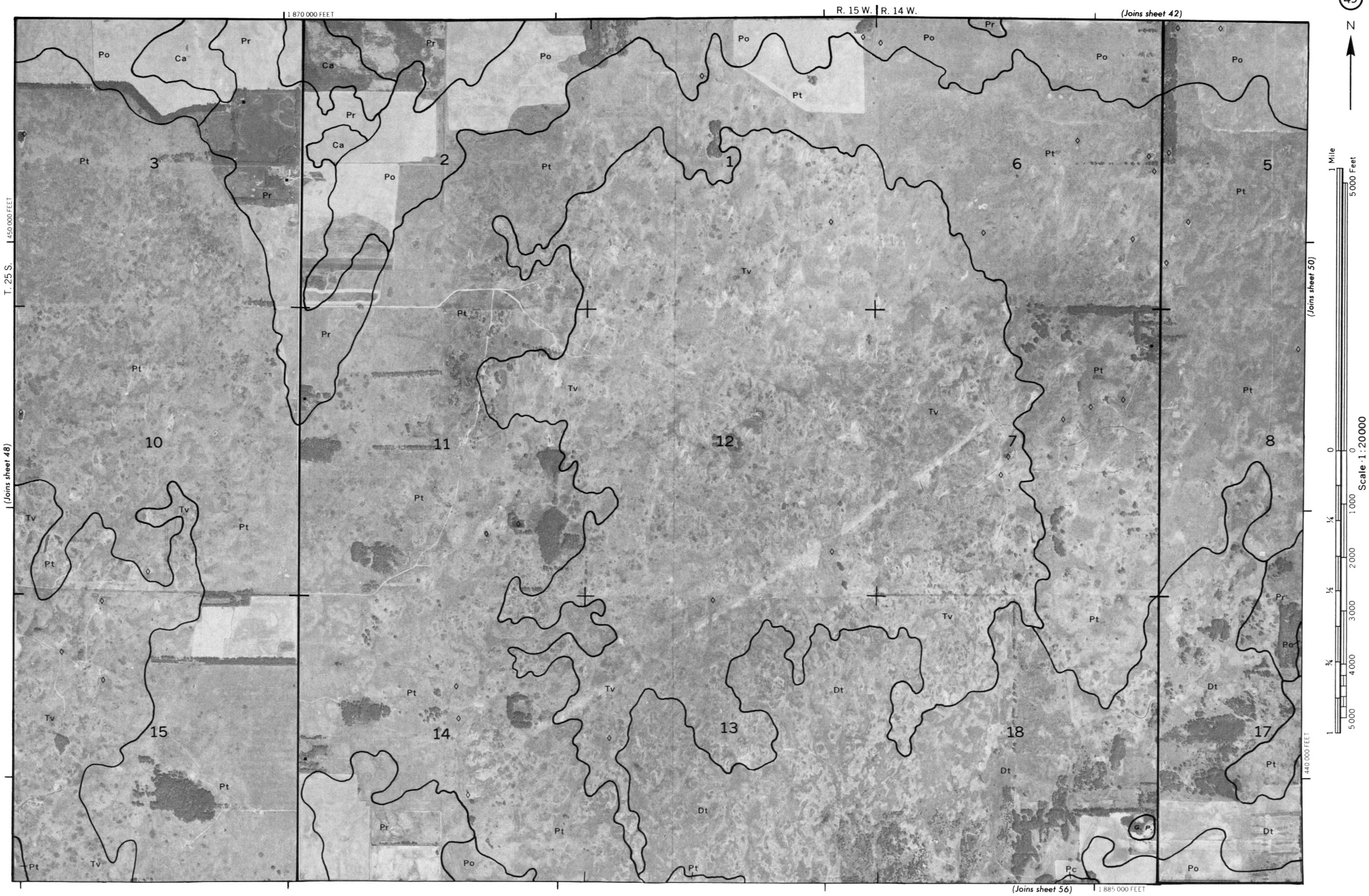
STAFFORD COUNTY, KANSAS NO. 47

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



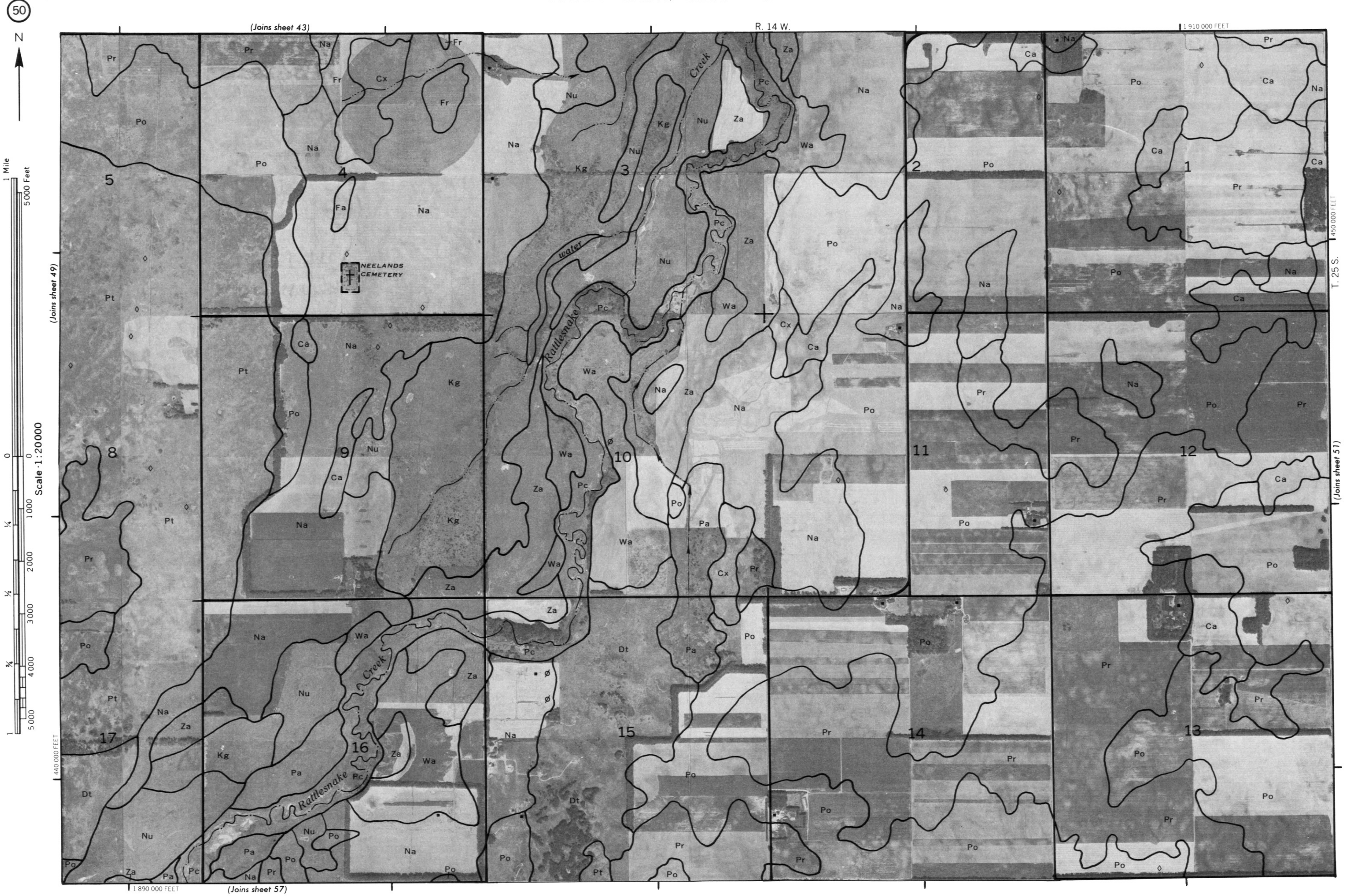
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 49

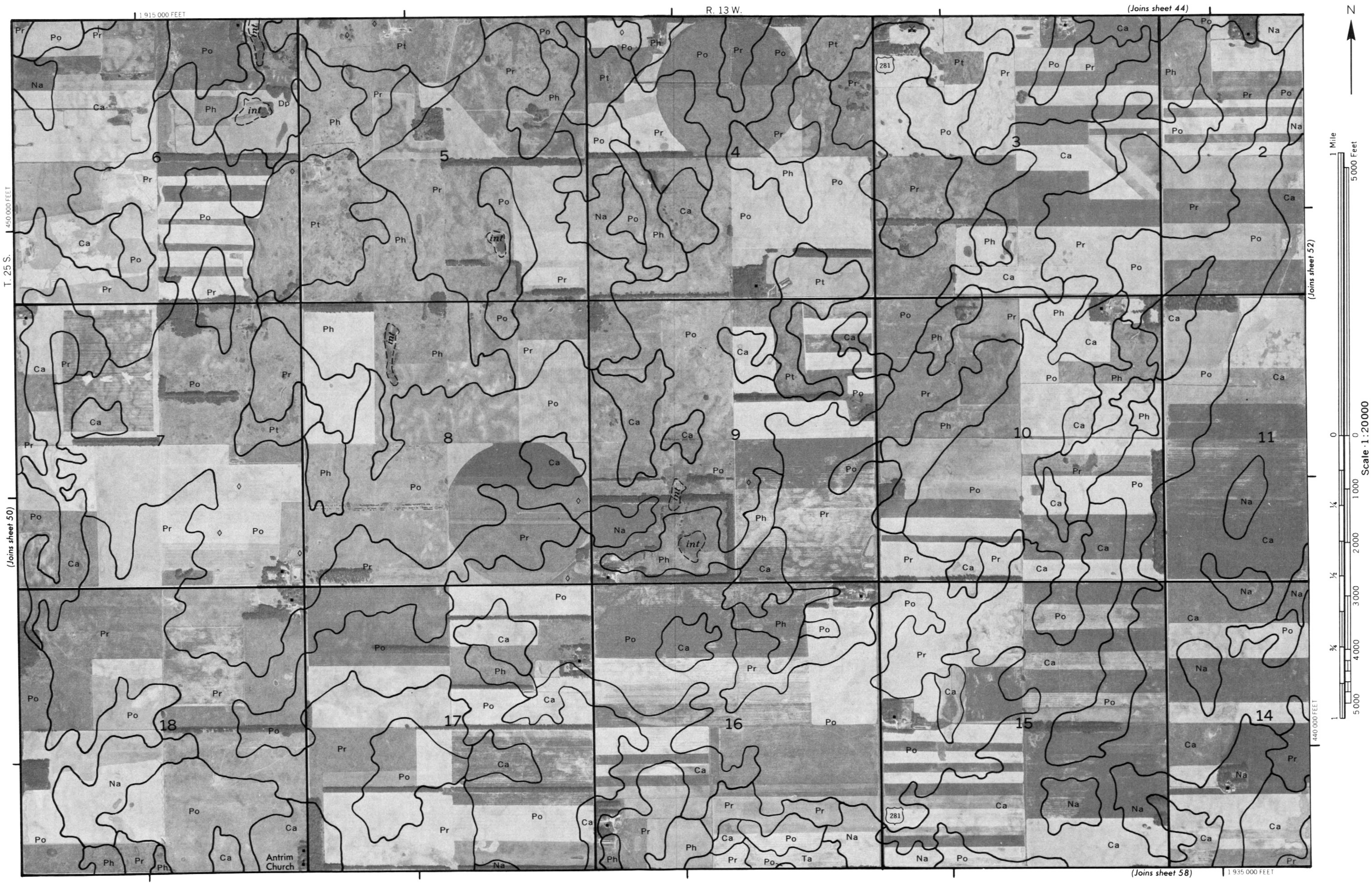


STAFFORD COUNTY, KANSAS NO. 49

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



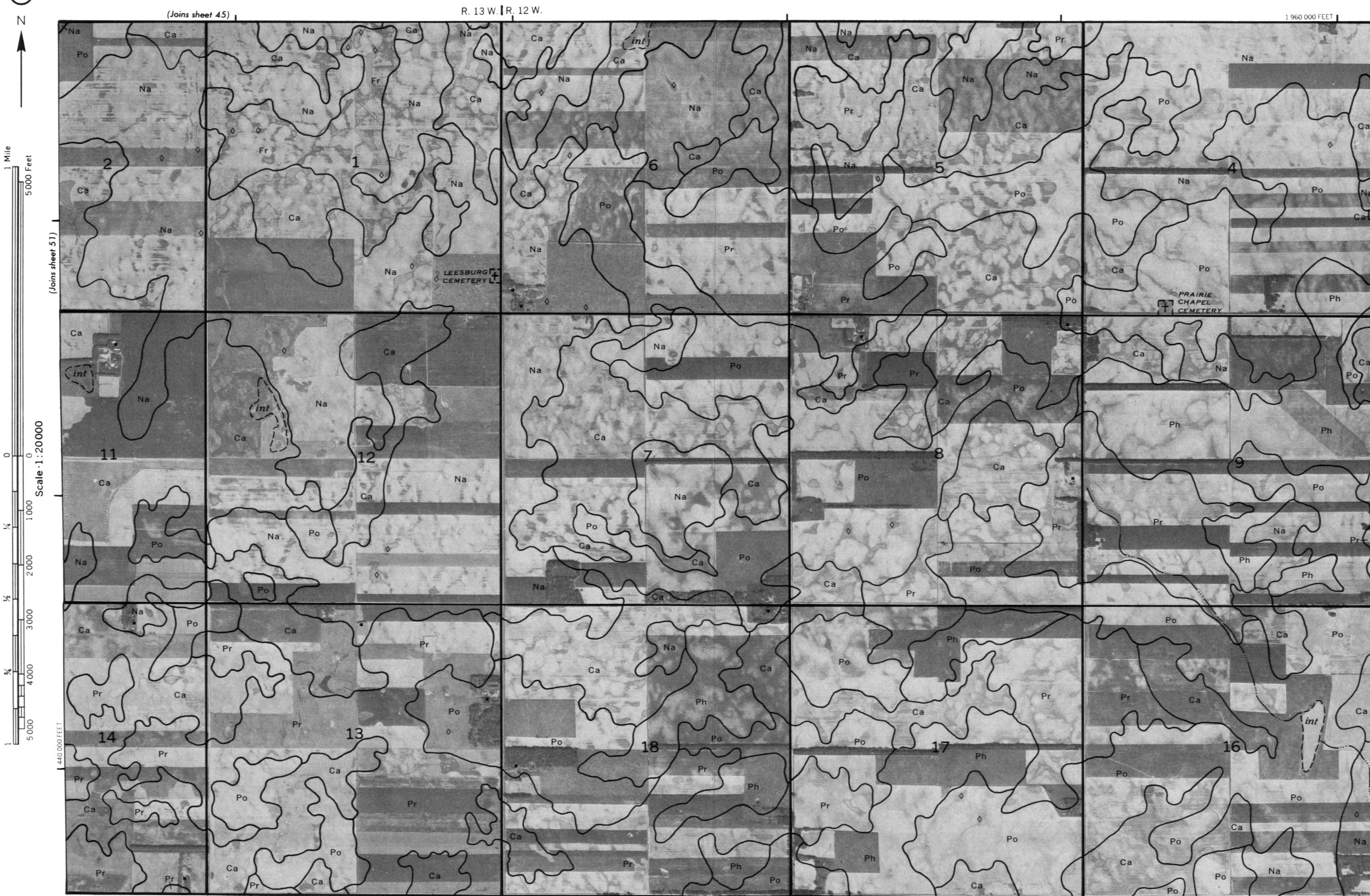
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



STAFFORD COUNTY, KANSAS NO. 51

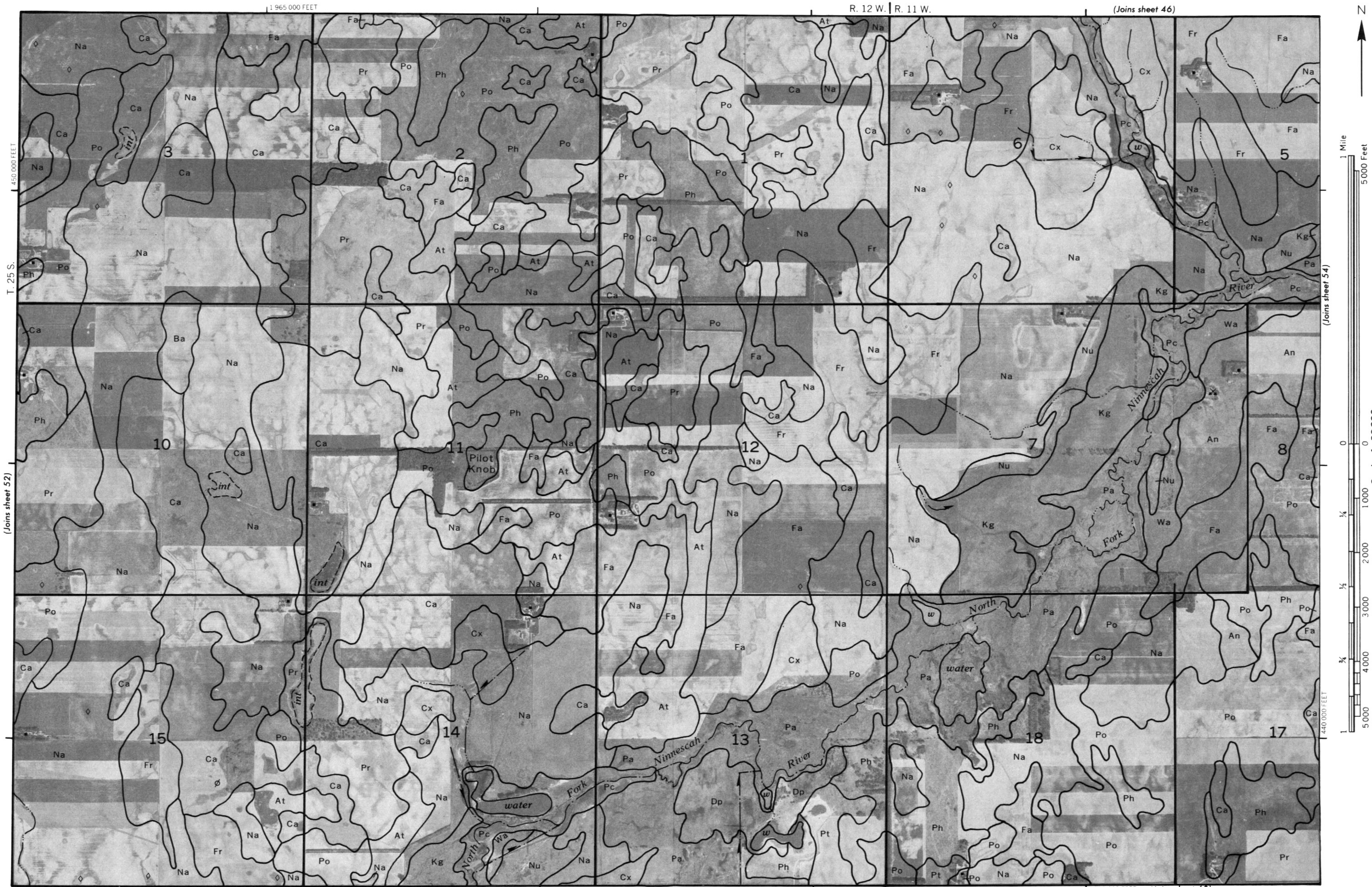
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 52



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS NO. 52



STAFFORD COUNTY, KANSAS NO. 53

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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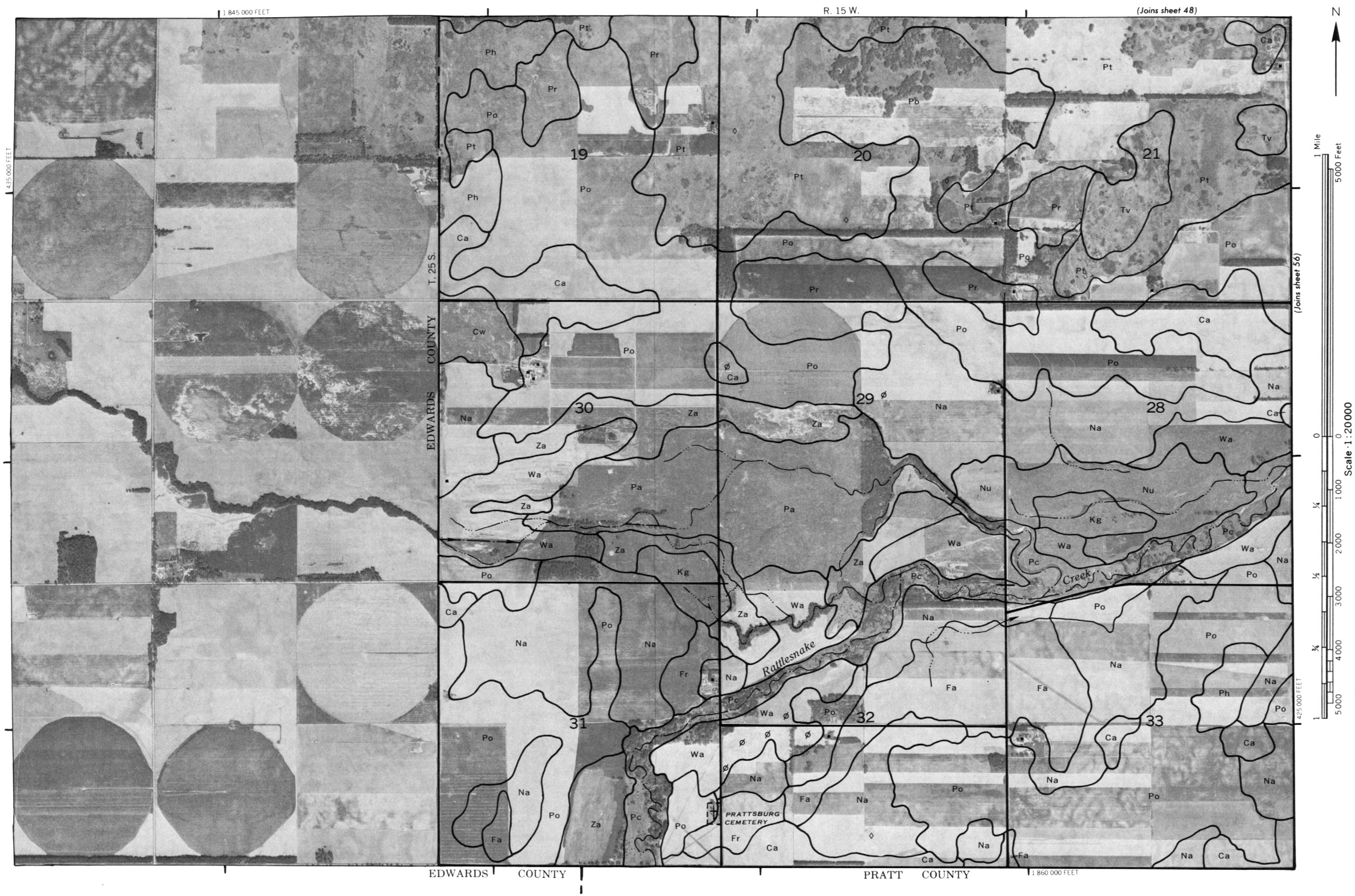
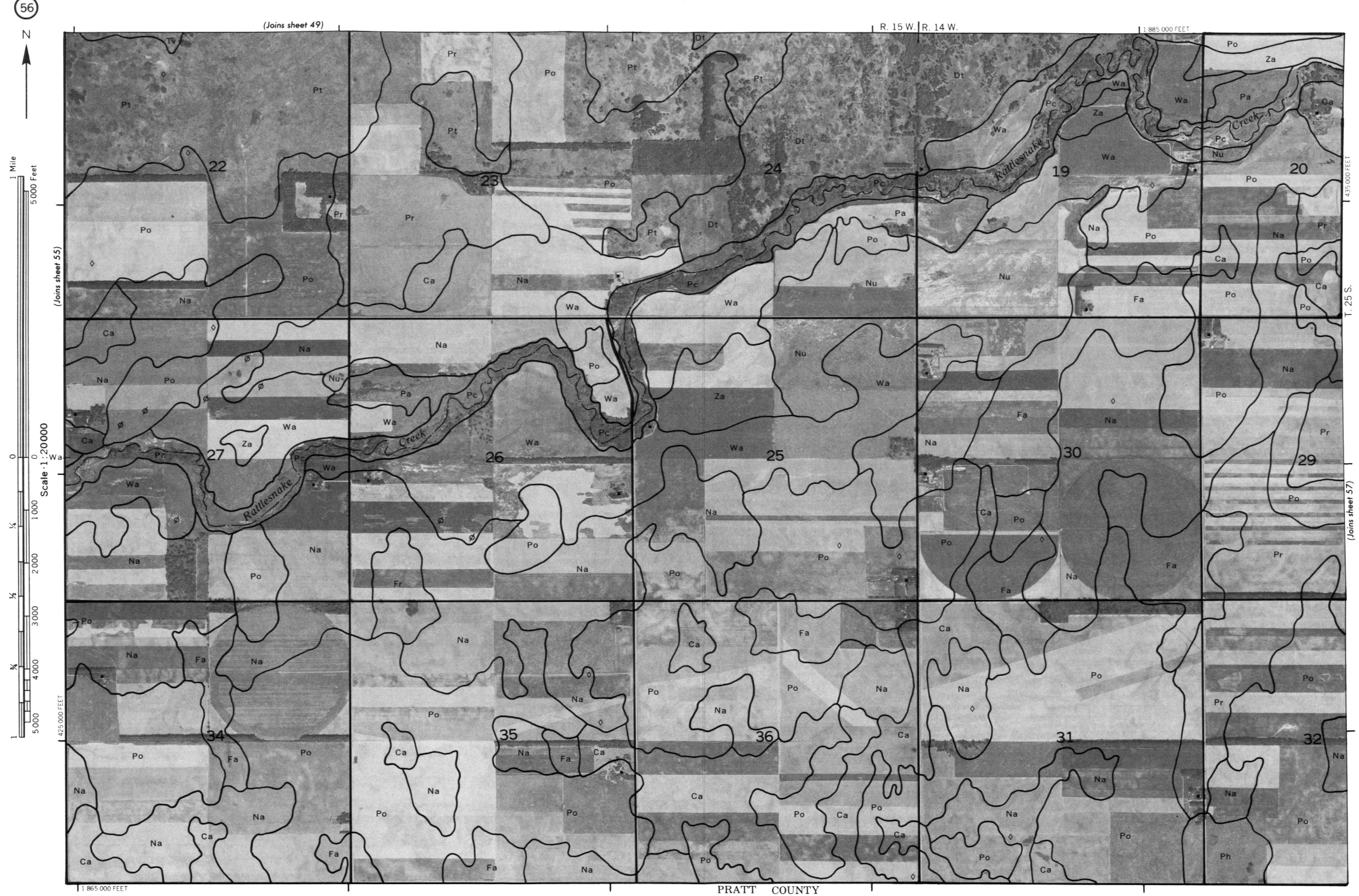
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS NO. 55

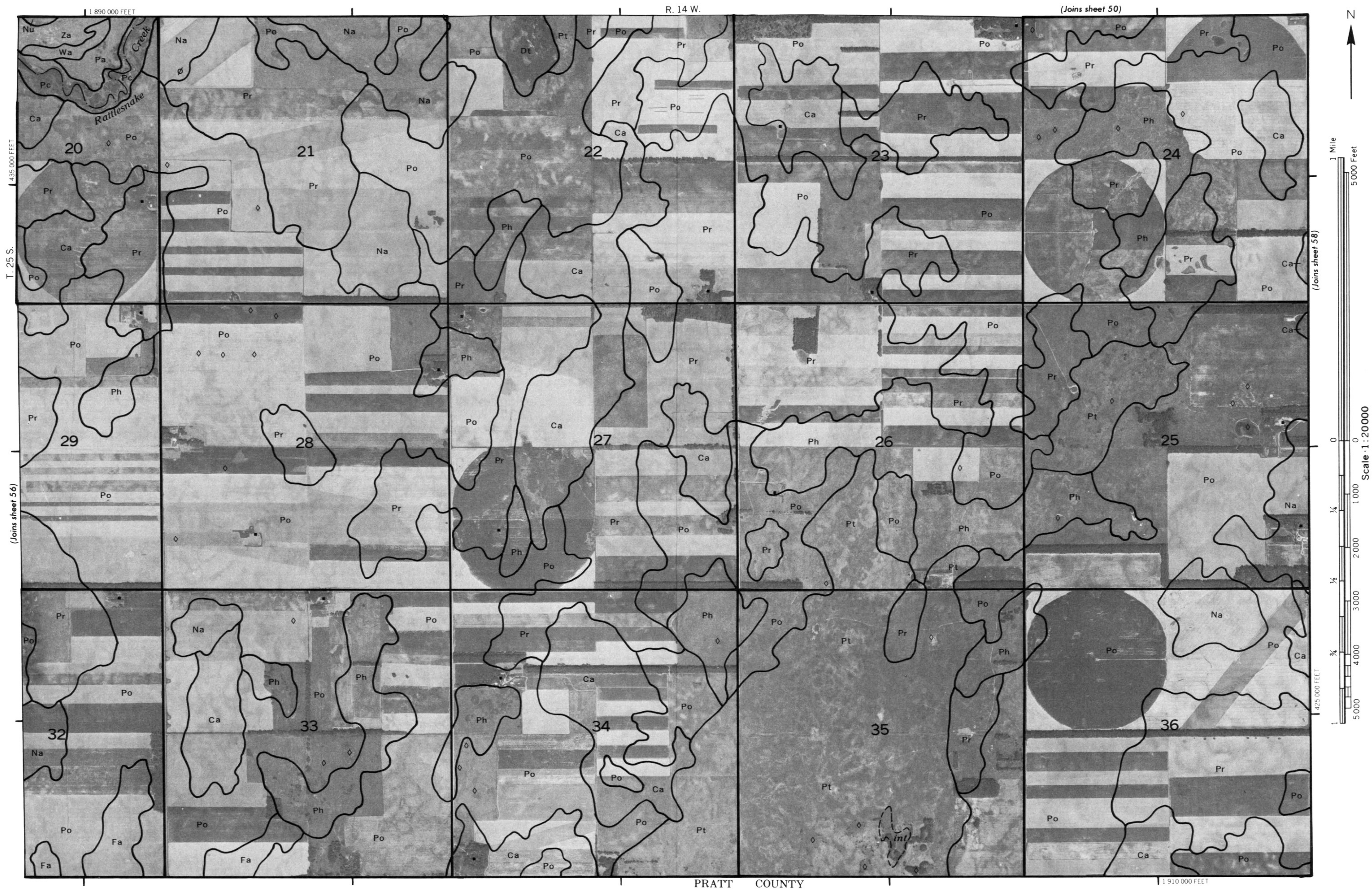
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

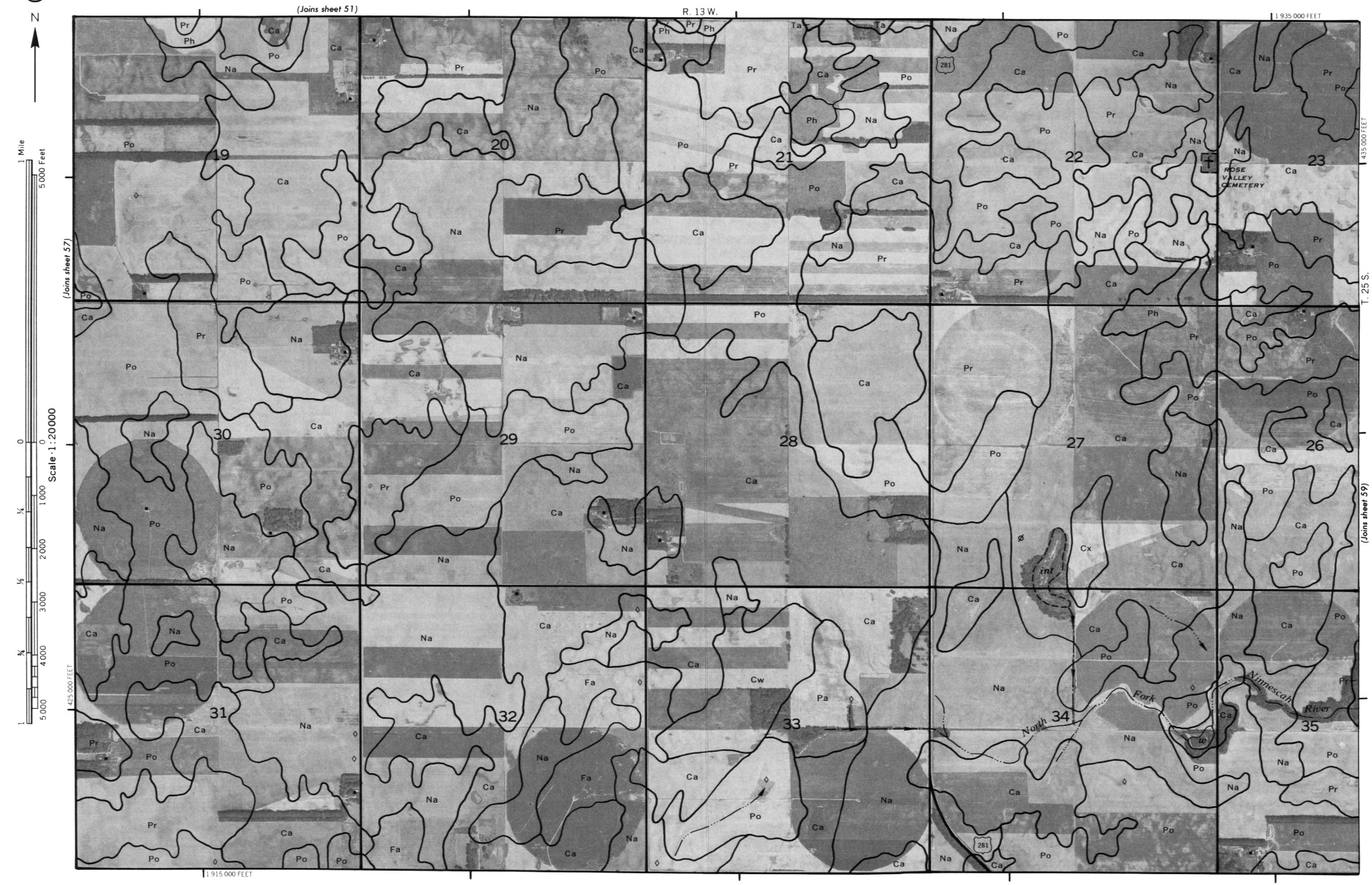
STAFFORD COUNTY, KANSAS NO. 56



STAFFORD COUNTY, KANSAS NO. 57

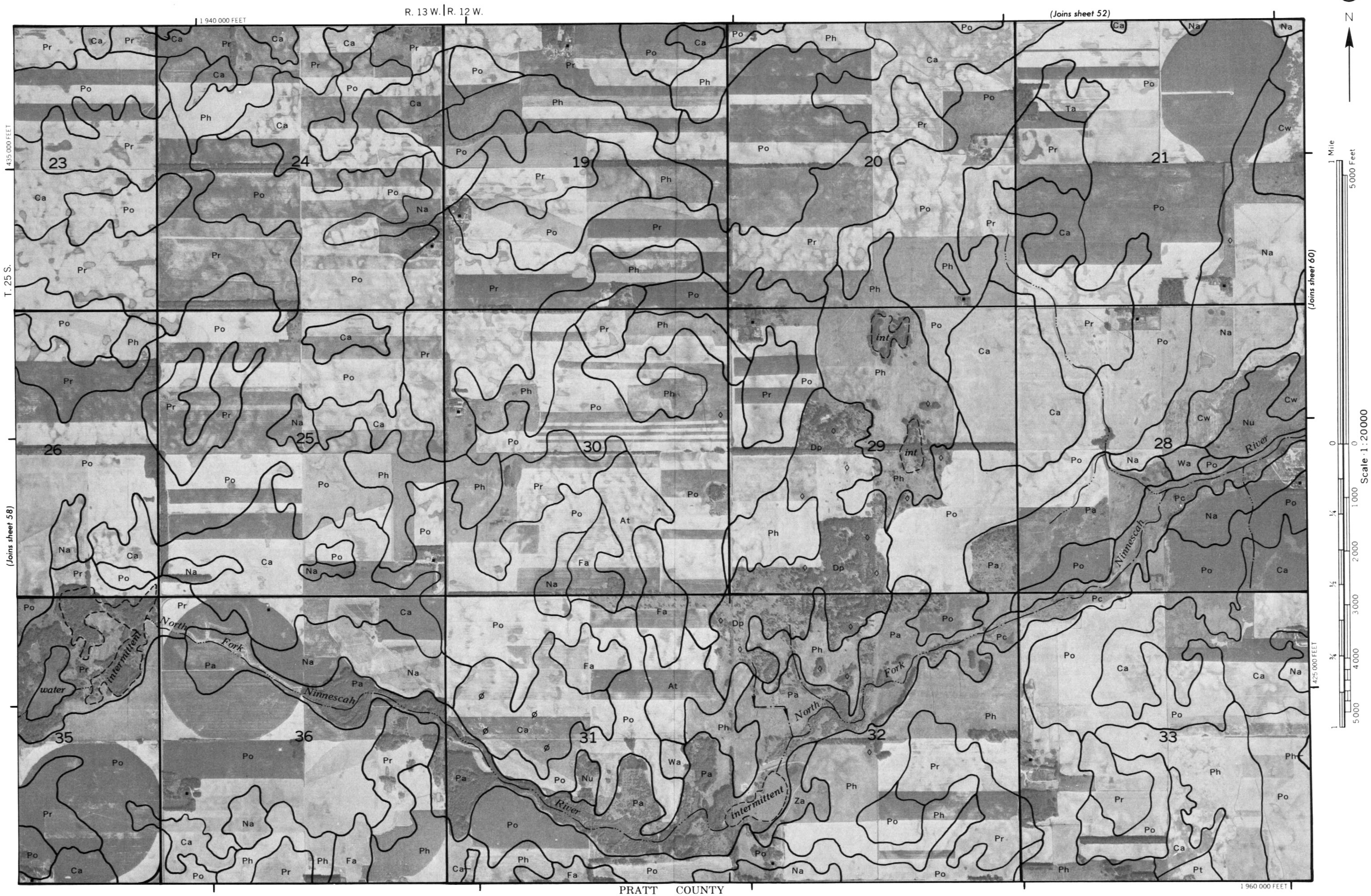
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 58



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

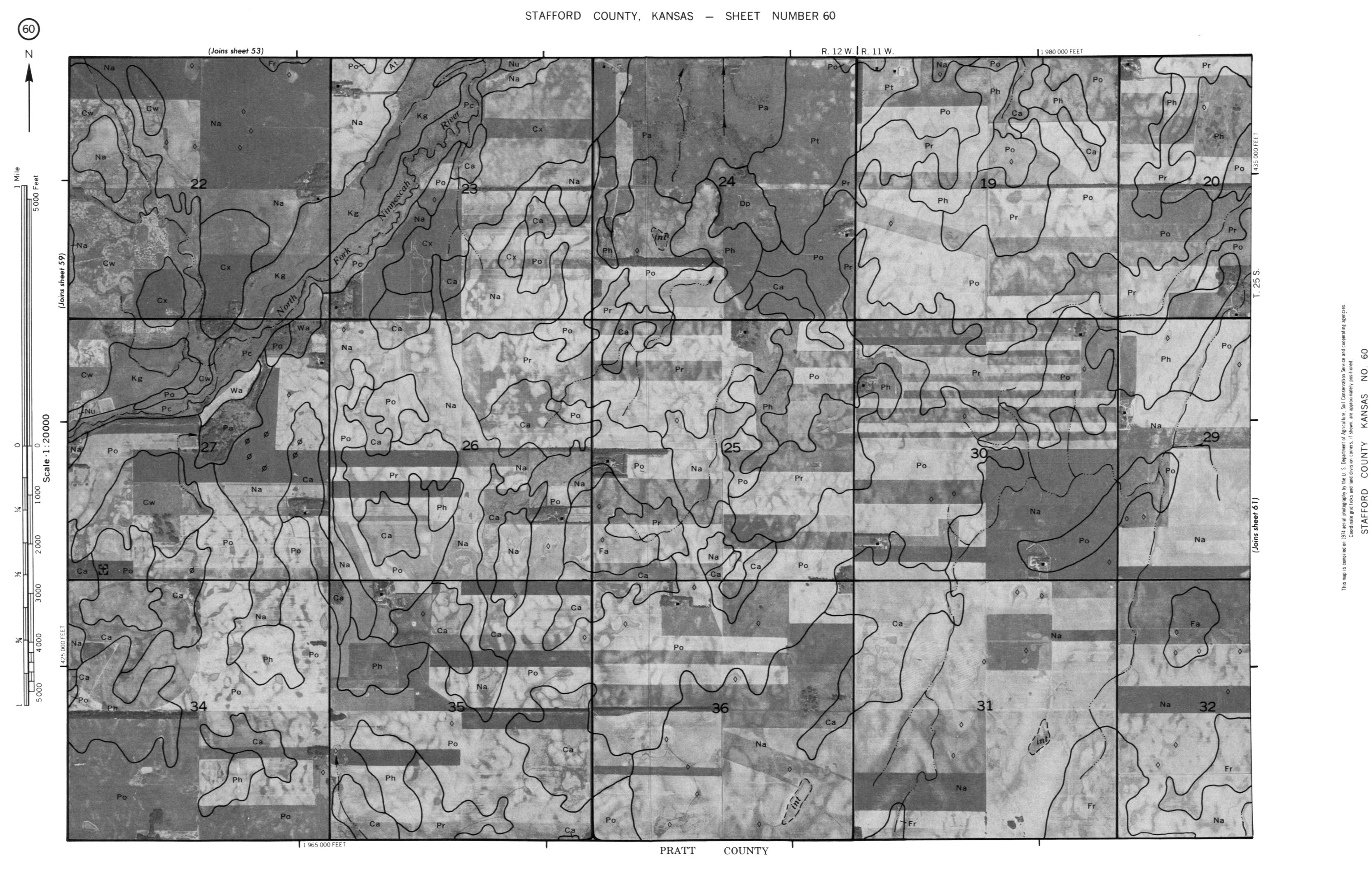
STAFFORD COUNTY, KANSAS NO. 58

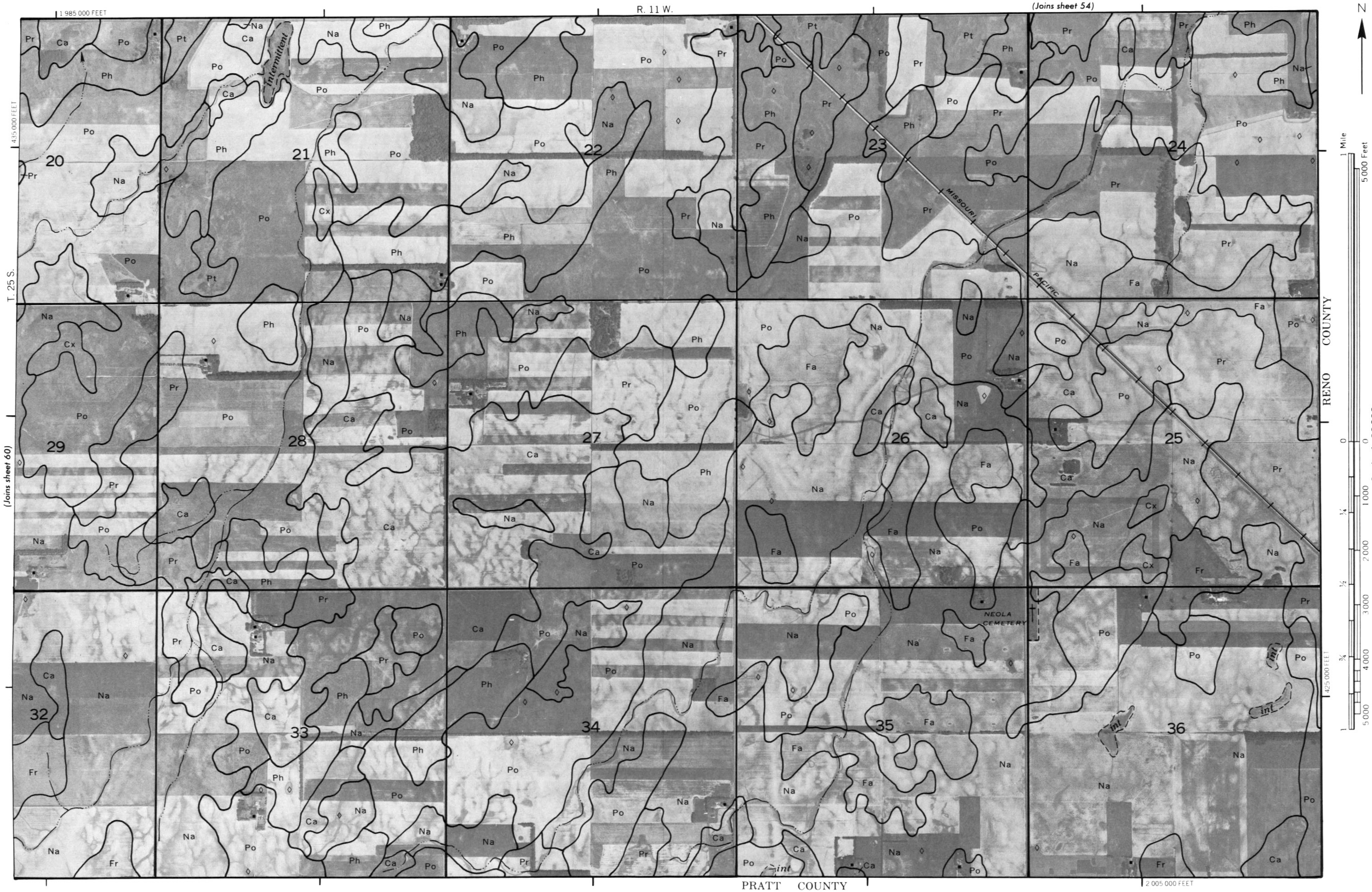


STAFFORD COUNTY, KANSAS NO. 59

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STAFFORD COUNTY, KANSAS — SHEET NUMBER 60





STAFFORD COUNTY, KANSAS NO. 61

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.